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BIOLOGY 20

The Biosphere

Module 1



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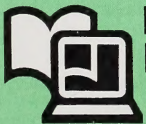
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Biology 20

Module 1

The Biosphere



**Distance
Learning**

Alberta
EDUCATION

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Biology 20
 Student Module
 Module 1
 The Biosphere
 Alberta Distance Learning Centre
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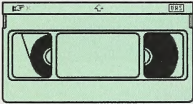
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Welcome to Biology 20!

We hope you'll find this course interesting and fun. To make your learning a bit easier, watch the referenced videocassettes whenever you see this icon.

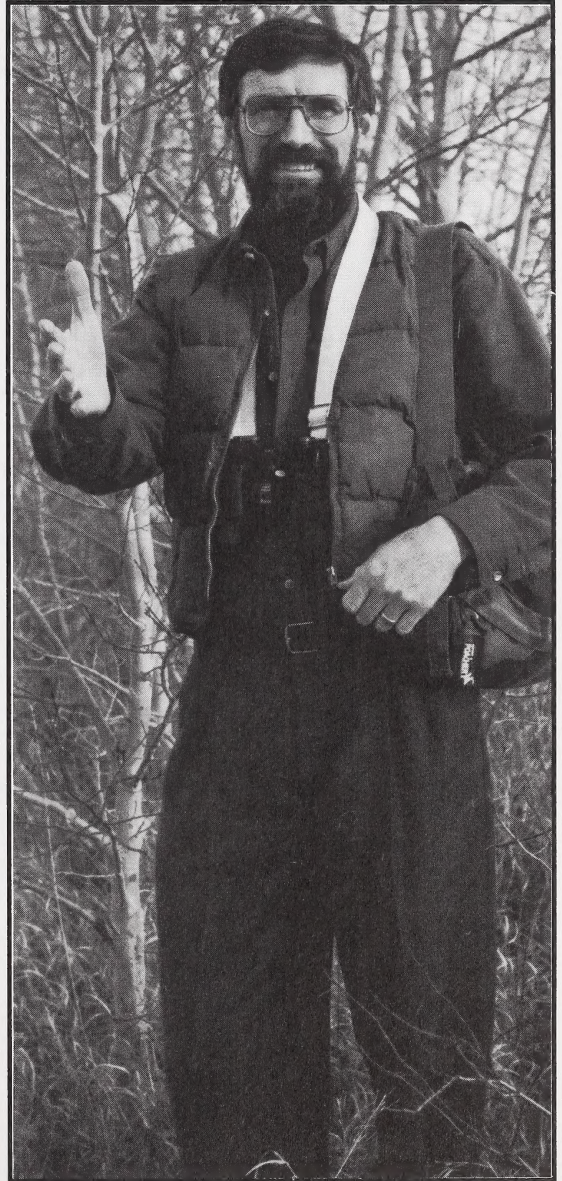
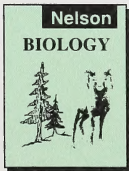


You also have the option of viewing laser videodisc clips when you see a bar code like this one.



48350

When you see this icon, study the appropriate pages in your textbook.



Good Luck!



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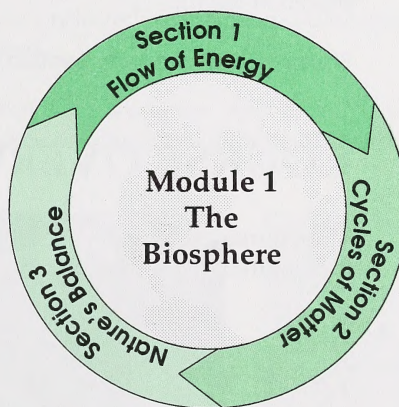
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OVERVIEW

Imagine for a moment a warm summer day: blue skies, puffy clouds, green grass, birds and other animals moving about, yourself soaking up the rays. Ah, isn't life great? Do you realize there may be only a few places in the universe that support life like this? In fact the Earth may be unique. What makes the Earth so special that it has a biosphere? And how safe is it? Is it getting better or worse? It's your world and in Module 1 you'll learn more about it. You'll study how energy flows and matter cycles in the biosphere and how a natural balance makes life possible. You'll also look at how life on Earth is threatened by the impact of human activities.



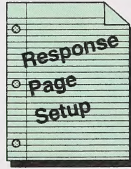
Evaluation

Your mark in this module will be determined by how well you do the assignments for each section at the end of the module booklet. You must complete all three section assignments. The assignment breakdown is as follows:

Section 1 Assignment:	30 marks
Section 2 Assignment:	40 marks
Section 3 Assignment:	<u>30 marks</u>

TOTAL 100 marks

Work slowly and carefully. If you are having difficulties, go back and review the section. Read all parts of your assignment carefully. Plan and do your rough work on your own paper. Revise and edit your responses; then set up your final copy for submission on your own paper. Lined looseleaf paper is recommended. Make sure your answers are neat and organized, with a wide left margin and space for teacher comments left after each assignment.



When you see this icon, ideas and details are provided to help you set up and organize your answer in a certain way.

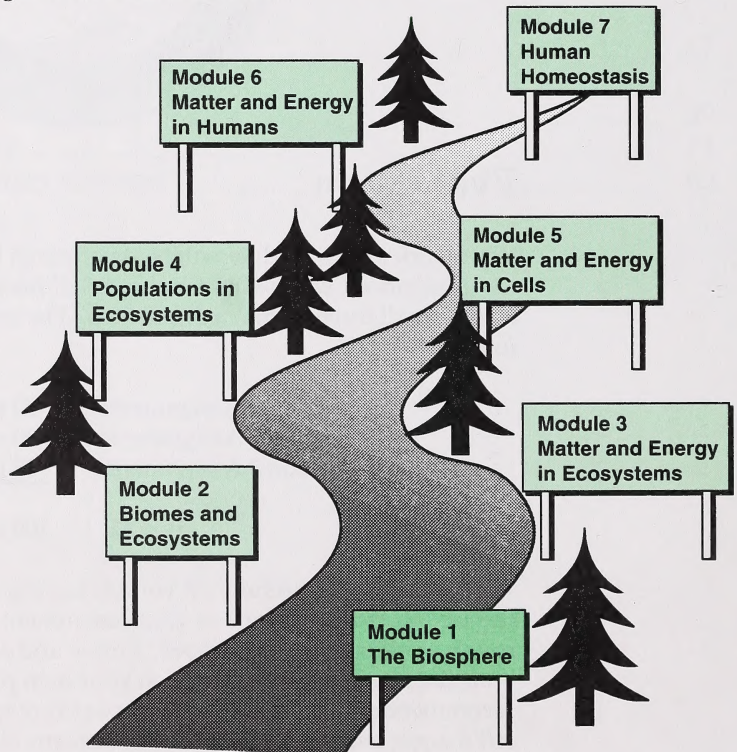
Before submitting your responses, be sure to proofread them carefully to ensure they say what you want, that they are neat and clear, and that they are complete and missing no material.

It is important to number and clearly identify each page with this information placed at the top.

Biology 20 – Module 1 Section # Assignment Page # Name and ID Number

COURSE OVERVIEW

This course contains seven modules. The module you are working in is highlighted in a darker colour.



Science Skills

One of the exciting features of this course is that you will develop and improve your ability in the area of science skills. These skills include

- initiating and planning
- collecting and recording
- organizing and communicating
- analysing
- connecting, synthesizing, and integrating
- evaluating the process or outcomes

Although these skills are referred to as science skills, it is important to remember two key ideas.

First, these skills are not just for science. Any time that you solve a problem or make a decision, some combination of these skills will be used.



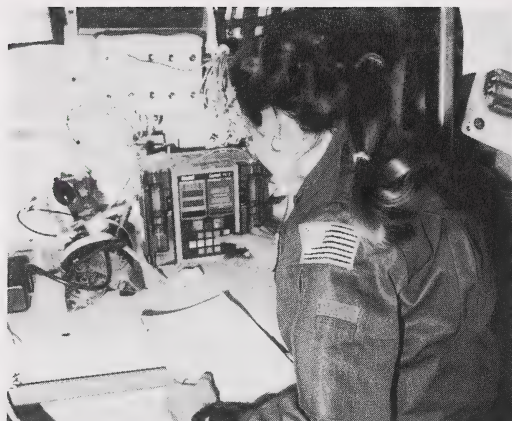
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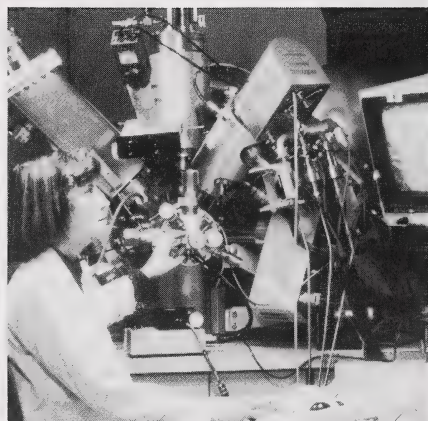
Courtesy of D. Merrills

Therefore, the skills you will develop in this course will be very useful for life-long learning. Nearly every activity of your life will require you to solve a problem or make a decision. Some people would even argue that, in the long run, the skills are more important than the particular topics that you study.

Second, you will be free to use these skills in a variety of ways. It would be wrong to assume that every scientist uses these skills in the same way to solve every problem. Science is very much a human activity, which means individuality and creativity play a large role.



NASA



NRC/IMS

The society that the person lives in, the technology that is available, and the very personality of the scientist will determine which skills are combined to create a solution to a problem.

It follows from this idea that the science that you do and the science skills that you prefer to use will be unique to you; and that's okay. It also follows that you likely will not be performing at the same level for all skills, which is a natural thing. In this course you will continually practise all of these skills and you will have an opportunity to assess your level of performance in each skill.

These science skills will be developed further in Activity 1 and explained in detail in the Appendix for this module.

Important Note

There are no response lines to write on in many of the questions asked in the student module booklets of this course. This means that you will need to have lined paper handy at all times on which to answer the questions. You will also require your own graph paper. It's probably a good idea if you keep your answer pages in a binder so they are easier to refer to when reviewing. Read all the questions carefully and answer them as completely as possible. Then check your answers in the Appendix. This will allow you to assess your growing abilities in this course.

It is also important that you work through the module activities thoroughly before attempting the questions in the assignments. This will help you to achieve a greater degree of success in your studies.

Flow of Energy



PHOTO COURTESY OF CHINOOK RIVER SPORTS LIMITED

Have you ever gone whitewater rafting? Can you imagine the excitement of waves splashing over your face and the wind chilling your back as you cling tightly to your paddle? These are not your everyday events but they are special chances to experience first hand a flow of energy, literally to ride a wave!

In this section you are going to investigate the flow of energy through the biosphere. You will examine the transformations, storage, and loss of energy that constantly support life on Earth.

You will also become familiar with science skills that are developed in this course. The first activity in this module will introduce you to how these skills are recognized, practiced and evaluated. Then you will begin your study of the biosphere.

ACTIVITY

1

Science Skills



Courtesy of D. Merrills



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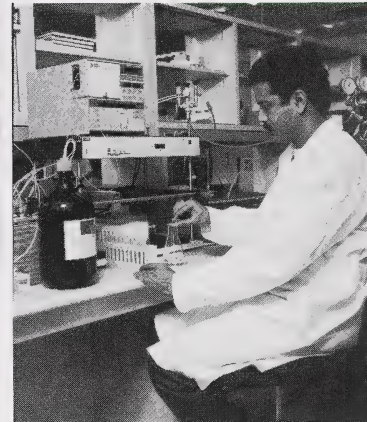


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Many people imagine scientists as very brainy people in lab coats doing experiments on mysterious substances. This is not a total picture. Look at the scientists in the three pictures. Yes, they are all scientists! There is a difference in their age and in the complexity of their investigations but they are all practising science skills. Think about it. The trip to the pond required a lot of planning, some equipment, and transportation. These are skills. The kids by the pond probably won't do any sophisticated classification like the students in the lab but they may make some observations and maybe some comparisons. The students in the lab will be making observations and comparisons and will be classifying specimens. They may even collect data over time and write a report of their findings. They may not go as far as to analyse their data or design an apparatus to test a theory – like the research scientist in the last picture. This would require more time and more skills.

As a student in this course you are a beginning scientist. You may feel a bit short on knowledge and skill but that's why you're here. Throughout this course you will increase both your knowledge and your science skills. You will also keep track of your progress. So what skills will be developed and how are they measured? Some of this work has already been done for you.

Following is a list of science skills developed in this course. A more detailed explanation of each skill is in the Appendix of this module.

Science Skills

- A. Initiating and planning
- B. Collecting and recording
- C. Organizing and communicating
- D. Analysing
- E. Connecting, synthesizing, integrating
- G. Evaluating progress or outcome

So, do scientists practise these skills all the time? This is a good question. Generally scientists are able to practise any or all of these skills but may only use certain skills in certain situations. As a science student you will do the same. Here's the idea. Look at the three pictures at the beginning of this activity and then answer questions one to three. Take your answers from the list of science skills.

1. What skills are the young people by the pond practising?
2. What skills are being practised by the students in the laboratory?
3. What skills are being performed by the research scientist?

Check your answers by turning to the Appendix, Section 1: Activity 1.

Alright, so you're not a 10-year-old with a pail and a net or a research scientist at the Alberta Research Council. Where do you fit in? In Biology 20 that's where! Don't worry if you think some of your skills are rusty. With practice any skill is likely to improve. Skills in this course have levels of improvement that you will experience. Take a look at the science skill levels in the Appendix. Compare level 1 to level 4 under skill A, *Initiating and Planning*. Notice how the skill level changes. You may already be at skill level 3 in some skills.

Science Skills

- ☐ A. Initiating
- ☒ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

How specific are these skills? Well, can you draw a graph? Check level 3 in skill C, *Organizing and Communicating* in the Appendix.

Science skills are practised in Biology 20 in a user-friendly way. Throughout the modules science skill icons will tell you when particular skills are applied. Notice the icon beside question 1 in Activity 2. In the assignments, another skill icon is used to assess your skill level. Assess? That's right. But there is a difference; both you and a teacher will assess your science skills. Immediately after answering an assignment question you will evaluate your skill level in a box like this:

Self: A.		B.		C.		D.		E.		F.	
Teacher: A.		B.		C.		D.		E.		F.	

When you get your corrected assignment back you will transfer both assessments to a chart at the back of Module 1 Appendix.

Here's an example:

Look at the Investigation: Solar Radiation in Section 1, Activity 2. Notice that skills C. *Organizing* and D. *Analysing* will be practised. Organizing the data means taking data from the tables and constructing a graph. Analysing the graph must be done to answer the questions that follow. No synthesis or evaluation is practised here.

Now flip to question 4 in your Module 1 assignments. Do not try to answer the question at this time. Just look at the skill assessment procedure. Notice that in this question skills C, D, E, and F can be assessed. Skills C and D pertain to constructing and reading a graph. Skills E and F pertain to the questions that follow. Now, assume that after answering this question you felt your skills were quite good so you filled out the assessment box like this:

Self: A.		B.		C.	4	D.	4	E.	3	F.	3
Teacher: A.		B.		C.		D.		E.		F.	

And when the teacher assessed your science skills they indicated this:

Self:	A.		B.		C.	4	D.	4	E.	3	F.	3
Teacher:	A.		B.		C.	3	D.	3	E.	4	F.	3

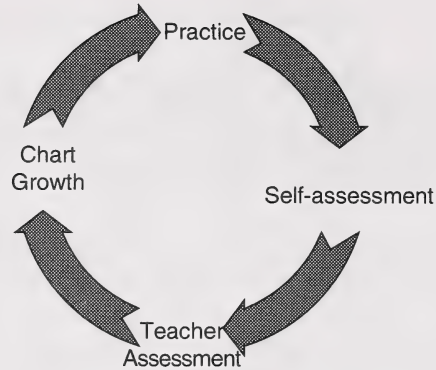
By comparing your assessment to the teacher assessment you can see they are very close. A little improvement could be made in skills C and D but in skill E you are at level 4 already. A good start! In skill F both you and the teacher agree on your skill level. The teacher may write you a short note explaining any differences.

Now you would record both your assessment and the teacher assessment on the data sheet at the back of the Module 1.

SKILL ASSESSMENT RECORD														
Feedback From Assignments			Initiating and Planning		Collecting and Recording		Organizing and Communicating		Analyzing		Synthesizing and Integrating		Evaluating	
Module	Section	Question	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher
							4	3	4	3	3	4	3	3



Will these science skill levels affect my grade on this assignment?



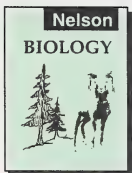
It is important for you to realize that this teacher skill level assessment should **not** be interpreted as part of your grade. Rather, it is valuable feedback to help you to know the areas where you need to improve. Everyone can improve their science skills. Now move on to your study of the Biosphere.

ACTIVITY

2

Thermodynamics and Energy Transformations

Your study of the biosphere begins with energy from the Sun. Solar radiation creates an environment hospitable to living organisms and provides the fuel for living processes. Many factors affect the distribution of solar radiation on the Earth.



To learn about these factors, read the section entitled Solar Energy and Global Temperatures on pages 26 and 27 in the text. When you have finished reading, answer the questions that follow.

If you have access to the laser videodisc program *The Living Textbook*, select frame 1652 in lesson 7.2, Ecosystem Dynamics. This is on side 7. Notice how the intensity of solar radiation would vary on the surface of the earth depending on latitude.

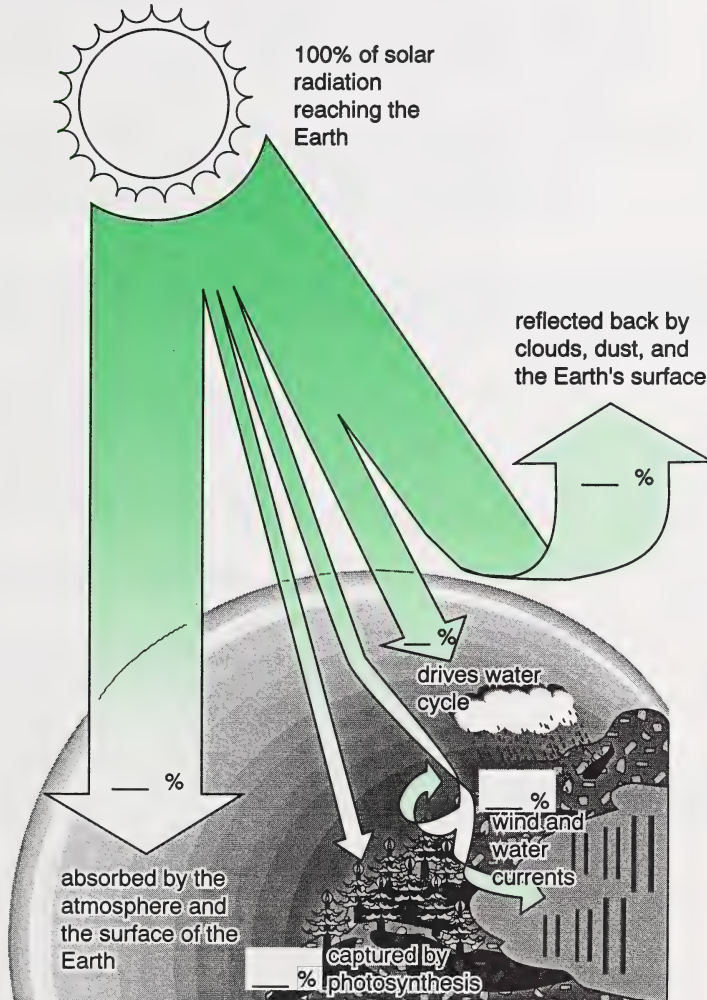


1652

Science Skills

- ☐ A. Initiating
☐ B. Collecting
☒ C. Organizing
☒ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

1. Using the data in Table 1.3 on page 26 of the text, complete the following illustration to show how the incoming solar radiation is apportioned to the Earth. Indicate the percentage of solar radiation on each arrow.



2. How do the seasons affect the amount of solar radiation received in Alberta during a year?
3.
 - a. What effect will cloud cover have on the incoming solar radiation?
 - b. How will this affect ground temperatures?
4. How do snow and ice affect the amount of solar radiation retained by the Earth?

Check your answers by turning to the Appendix, Section 1: Activity 2.

PATHWAYS

If you have access to the video *Energy and the Food Web*, do Part A.
If you do not have access to this video, do Part B.

Part A



View the video, *Energy and the Food Web*, which describes the flow of energy through the biosphere. The first five minutes of the program introduces this concept. Pay close attention to the next **seven** minutes of the program because it presents information about solar radiation. The final **eight** minutes completes the concept of energy flow.

Familiarize yourself with the following questions first. As you view the video answer the questions. Stop the tape whenever necessary.

Introduction (5 minutes)

battery farm – a place where artificial conditions exist

5. What conditions exist in a **battery farm** for chickens?
6. What are free range chickens?
7. Why do you think free range chicken eggs would be more expensive than battery farm chicken eggs?

Solar Radiation (7 minutes)

8. How is solar energy transformed into food energy?
9. What is a food chain?
10. How could you measure the warming effect of sunlight?
11. How do scientists measure solar radiation?
12. What is a bomb calorimeter and why is oxygen added to it?
13. Complete the following chart.

Sample	Energy Input	Energy Stored	Efficiency
Whole Plant	100 Joules/m ²	_____ Joules/m ²	_____ %
Leaf	100 Joules/m ²	_____ Joules/m ²	_____ %

14. Why is the efficiency of the whole plant different from that of the leaf?

Conclusion (8 minutes)

15. How could you measure the energy contained in insects?
16. Complete the following chart.

Example	Food Energy Input	Biomass Produced	Efficiency
Caterpillar	10 g (leaf)	_____ g	_____ %
Battery Farm Chickens	20 g (feed)	_____ g (egg)	_____ %
Free Range Chickens	100 g (feed)	_____ g (egg)	_____ %
Cat	50 g (meat)	_____ g	_____ %

Science Skills

- ☒ A. Initiating
- ☒ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

biomass – the dry weight
of any living organism

17. Why are battery farm chicken eggs less expensive than free range chicken eggs?
18. How does energy eventually leave **biomass**?

Check your answers by turning to the Appendix, Section 1: Activity 2.

Part B

Through agriculture, humans have tried to increase the efficiency of food production. But food production, whether cereal crops or domestic animals, still requires energy and raw materials. Efficiency is the name of the game. It may seem most efficient to let crops grow naturally or to raise animals in open pastures. But under these natural conditions growth may be slow and overall production may be poor. Farmers may be better off to have well-tilled fields and animals in barns and pens, but these conditions are costly. Where is the happy medium? Can technology help?

A battery farm is a place where animals are raised under totally controlled conditions. While this may seem very expensive, high production makes it very efficient. Carefully read questions 5 and 6 (in Part A).

Now, make a prediction for question 7 and check your answers in the Appendix. Surprised? Read over questions 8 through 12 and check their answers in the Appendix. You should be able to guess the answers for questions 8 and 9 but the next ones are becoming technical. Look at the answer for question 13 and use it as data to answer question 14. Now check the data on the chart in the answer to question 16. Notice the difference in *efficiency* of the battery farm chickens compared to free range chickens. Try question 17 and 18.

Check your answers by turning to the Appendix, Section 1: Activity 2.



1653

If you have access to the laser videodisc program *The Living Textbook* look at frame 1653 in lesson 7.2, Ecosystem Dynamics on side 7. These are general temperature differences across North America.

Investigation: Solar Radiation

Objective

In this investigation, you will examine how solar radiation is measured and collected. You will also graph and analyse data that has been collected by the Atmospheric Environment Service of Environment Canada.

Background Information

Solar radiation is collected by scientists at various locations across Canada. These are shown on the map in Figure 1.1.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating



FIGURE 1.1 Solar Radiation Measuring Network

ATMOSPHERIC ENVIRONMENT SERVICE

For the purpose of observing solar radiation, several components are measured independently. These standardized components are referred to as Radiation Fields (RF). They are described and illustrated in Figure 1.2.

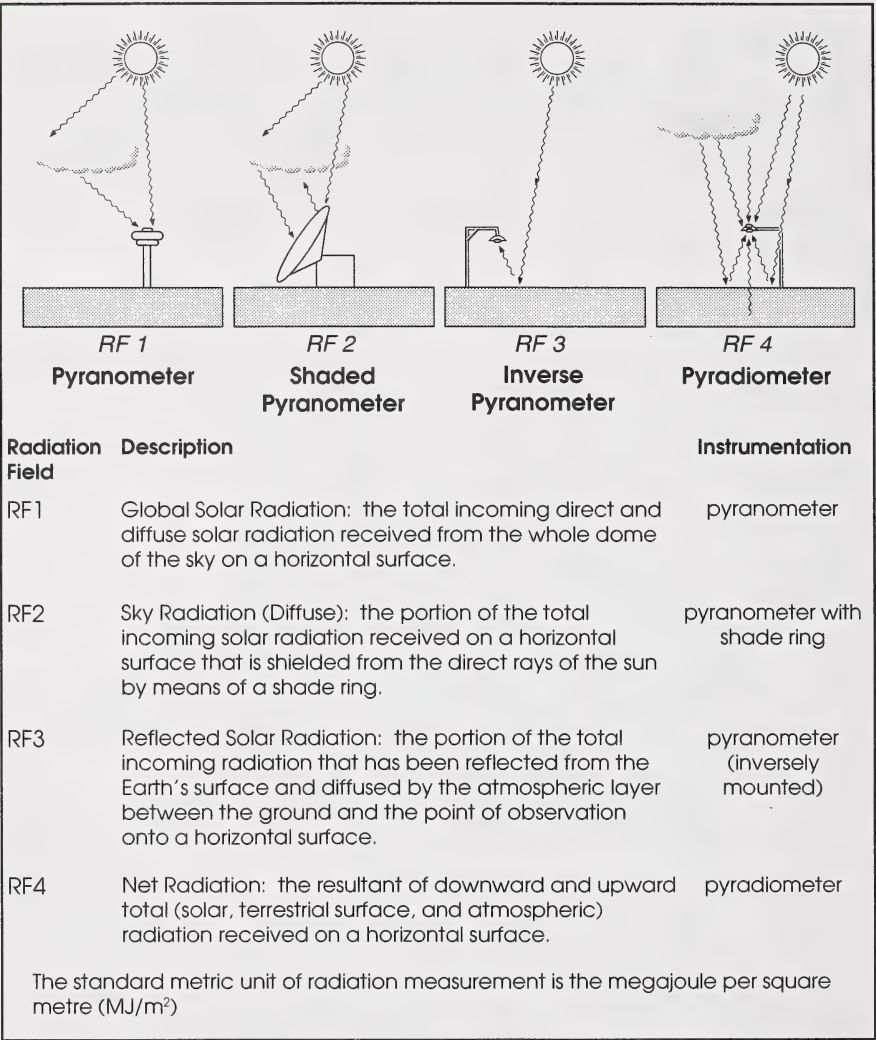


FIGURE 1.2 Solar Radiation Fields

ATMOSPHERIC ENVIRONMENT SERVICE

Procedure

Tables of sample data are provided. Using the legend shown in each graph, plot the data for each station. You will graph the information for each chart separately.

Observations

TABLE 1.1 Mean Daily Global Solar Radiation (RF1) in MJ/m²

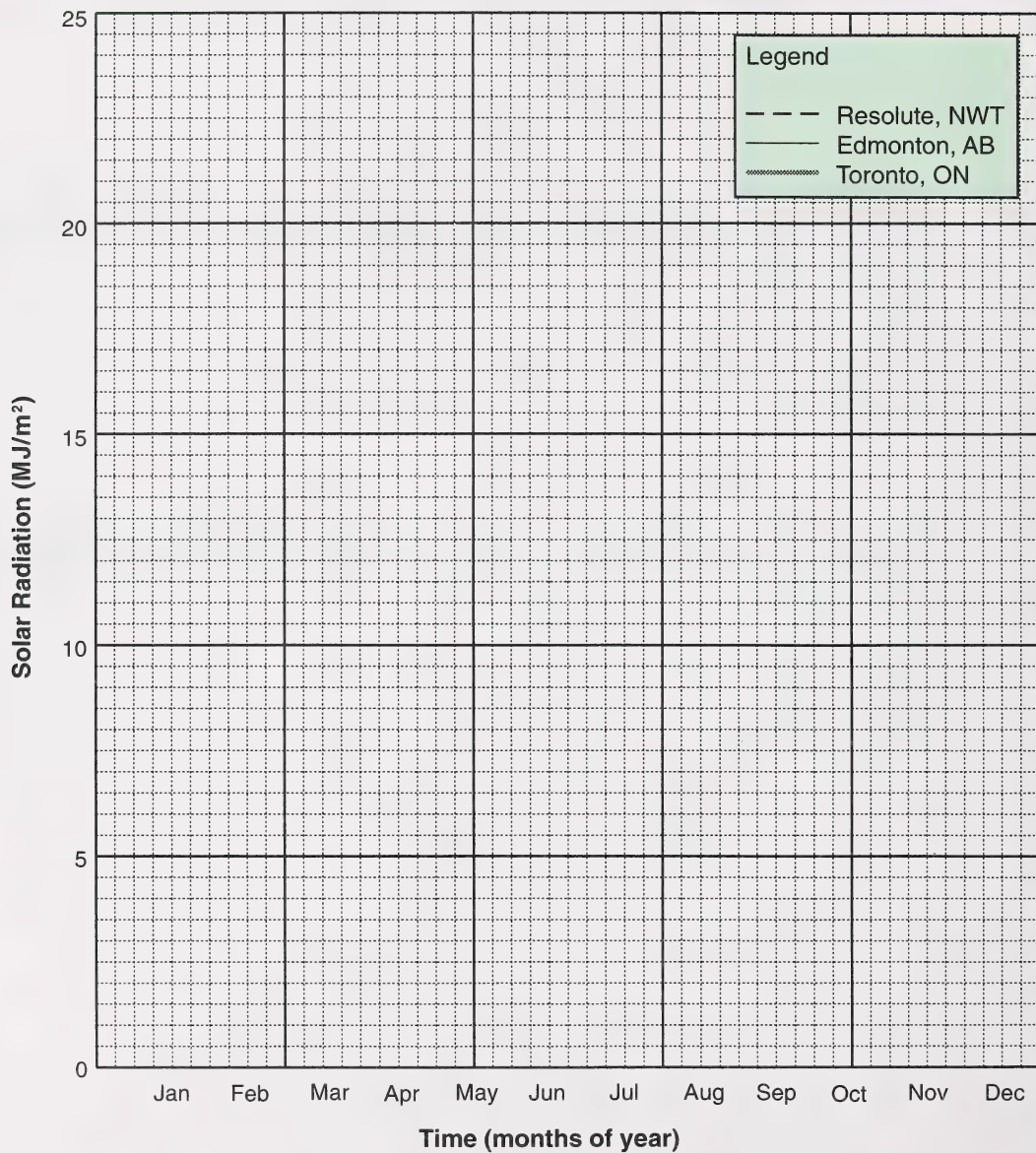
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Edmonton, AB	3.7	7.1	12.4	17.5	20.2	21.9	21.9	18.1	12.1	7.7	4.0	2.6
Resolute, NWT	0.0	0.6	5.2	14.7	23.1	24.9	18.7	11.0	5.2	1.3	0.1	0.0
Toronto, ON	6.1	9.3	12.9	17.3	20.0	21.7	21.9	18.7	14.1	9.1	4.8	4.3

TABLE 1.2 Mean Daily Net Radiation (RF4) in MJ/m²

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Edmonton, AB	-1.9	-1.2	0.9	6.5	9.1	10.5	10.5	8.2	4.2	0.7	-1.7	-2.0
Resolute, NWT	-2.2	-2.0	-1.8	-0.6	2.3	7.8	8.7	4.6	0.2	-1.7	-2.1	-2.1
Toronto, ON	-1.1	-0.3	3.5	8.3	9.9	11.4	11.3	9.5	6.0	3.0	0.6	-0.7

Analysis and Interpretation

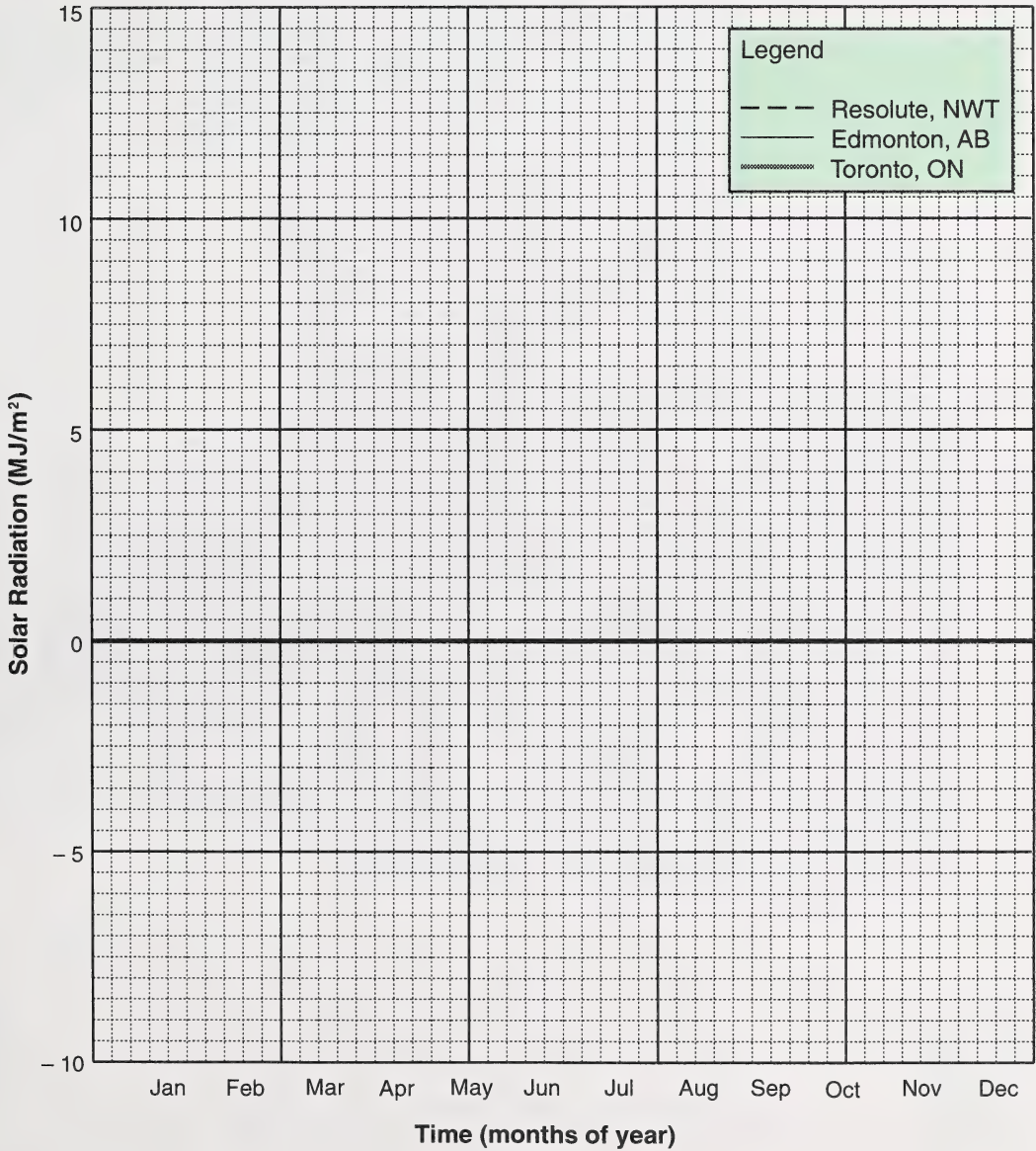
GRAPH 1.1: Mean Daily Global Solar Radiation (RF1)



19. Why does the amount of RF1 solar radiation change during the year in these three locations?

20. Which data line shows the least variation? Explain why the solar radiation in this location is more constant during the year.
21. When do all three locations receive the same solar radiation? Why?

GRAPH 1.2: Mean Daily Net Radiation (RF4)



22. Explain why the data lines go below zero for all three locations in January, February, and December.
23. Which data line has a plateau? Explain why this occurs.
24. When do the data lines cross?

Check your answers by turning to the Appendix, Section 1: Activity 2.

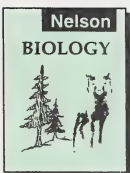


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In Science 10 you learned that you are really a solar-powered organism. From the investigation you have learned that where you live affects the solar power you receive.

How does this phenomenon take place?

To answer this question, read the section entitled Importance of Cell Energy on pages 176 and 177 in the text.



25. What is the purpose of photosynthesis?
26. What is the purpose of cellular respiration?
27. Explain how a plant is a good example of an energy system.
28. Why must there be a constant input of solar radiation for life to continue?

Check your answers by turning to the Appendix, Section 1: Activity 2.



PHOTO SEARCH LTD.

The behaviour of energy is best explained by the Laws of Thermodynamics. Read about these laws on Page 52 and 53 in the text. There is another explanation on pages 177 and 178. When you have finished the readings, answer the following questions.

29. State the First Law of Thermodynamics in your own words.

entropy – a measure of non-usable energy in a system

30. State the Second Law of Thermodynamics in your own words.
31. What would happen if maximum **entropy** existed on Earth?

Check your answers by turning to the Appendix, Section 1: Activity 2.

In the activities that follow, you will learn more about thermodynamics, the transformation of solar energy into chemical energy which can be stored in living things. The transfer and release of energy is essential to a balance of life in the biosphere.

ACTIVITY

3

Photosynthesis and Energy Storage



If you have spent some time watching wildlife in a forest, near a pond, or in a park, you know that living is an active process.

1. What are some of the activities of life that you see in the picture?

All of these actions require solar energy. Without plants there would be no energy available to living organisms. And the activity in this picture would not be possible.

Investigation: Solar Energy Storage

Objective

The purpose of this investigation is to demonstrate that plants store solar energy which increases their biomass.

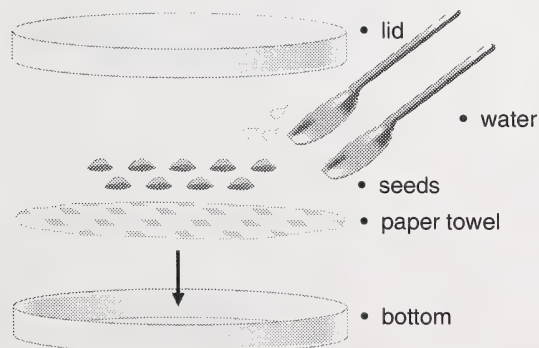
Materials

- 20 bean seeds
- 20 pea seeds
- 20 corn seeds
- 6 petri dishes
- 6 pieces of paper towel cut to fit petri dishes*
- tablespoon to measure water*
- balance beam scale
- scissors*

*supplied by student

Procedure

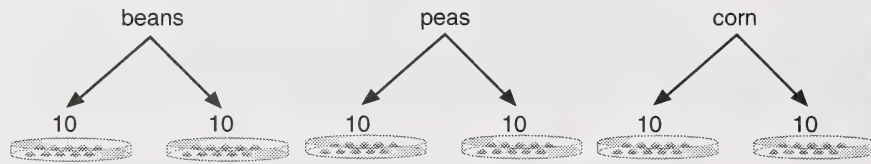
- Carefully cut the paper towel into circles that will fit in the petri dishes.
- Put a paper towel circle in the bottom of each petri dish. It will hold water for germination.



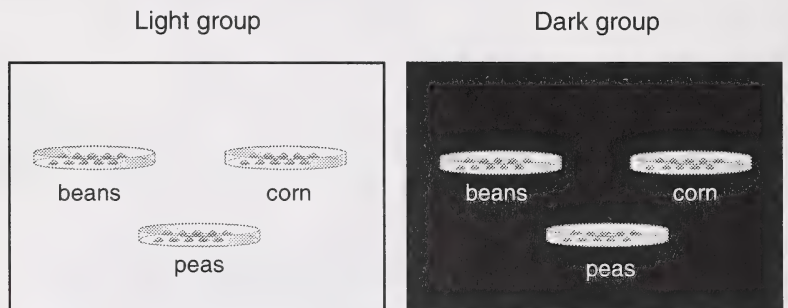
Science Skills

- ☒ A. Initiating
- ☒ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☒ F. Evaluating

- Divide each type of seed into 2 groups of 10 seeds each.
- Place 10 seeds in each petri dish.



- Add 2 tablespoons of water to each dish.
- Divide the dishes into a light and a dark group.



- Find the mass of each dish including seeds, paper and water. Record the mass on the **start** line of Table 1.3.
- Place the **Light** group of seeds in a well-lighted location. A sunny window sill would be just fine or a shelf in a bright room.
- Place the **Dark** group in a completely dark location such as a drawer.
- Weigh the seed dishes each day for 5 days and record the mass in the appropriate places on Table 1.3.

Observations

TABLE 1.3 Solar Energy Storage in Plants

Time	Bean Seedlings Total Mass (g)		Pea Seedlings Total Mass (g)		Corn Seedlings Total Mass (g)	
	Light	Dark	Light	Dark	Light	Dark
Day 1						
Day 2						
Day 3						
Day 4						
Day 5						

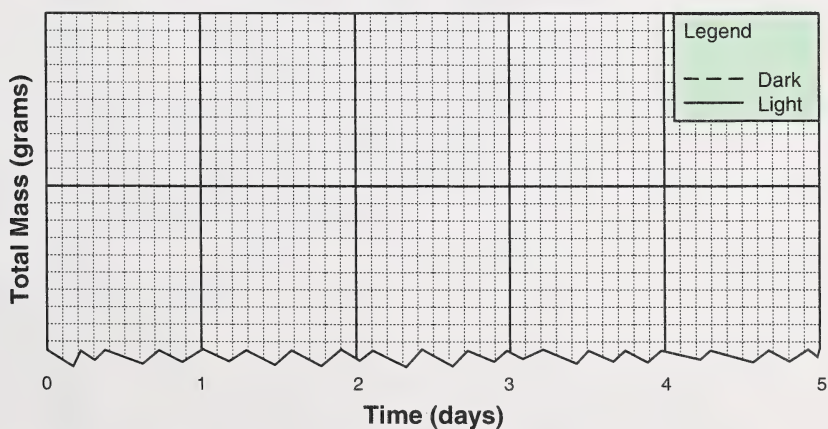
Analysis and Interpretation

- Use your own graph paper to compare the results in light and dark for each type of seed.

Title your graphs as follows:

- Graph 1.3 Solar Energy in Bean Seedlings
- Graph 1.4 Solar Energy in Pea Seedlings
- Graph 1.5 Solar Energy in Corn Seedlings

Look at the example to see how to label your graphs.

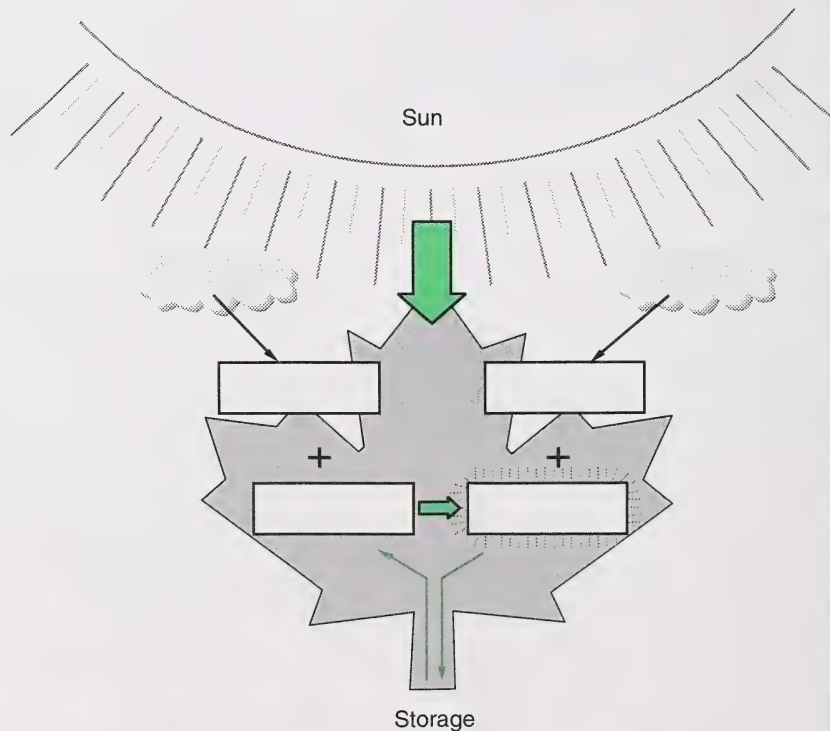


Answer the questions that follow.

3. Which seedlings stored the most solar energy over the five days? How do the graphs support your answer?
4. Why are ten seedlings of each type used in this investigation?
5. If seedlings growing in the dark cannot photosynthesize, why did their mass increase at all over the five days?
6. Predict the effect of placing the seedlings growing in light into an ice water bath.
7. What happens to the energy systems in plants during the ice and snow conditions of an Alberta winter?

In Module 5 you will learn more about the details of photosynthesis. For now, it should be clear that in photosynthesis solar radiation is stored in carbohydrates in plants.

8. To check your understanding of energy flow, complete the following flow chart boxes.





2362

If you have access to the laser videodisc program *The Living Textbook* refer to frame 2362 in lesson 7.2, Ecosystem Dynamics. This is on side 8 and shows photosynthesis in an energy cycle.

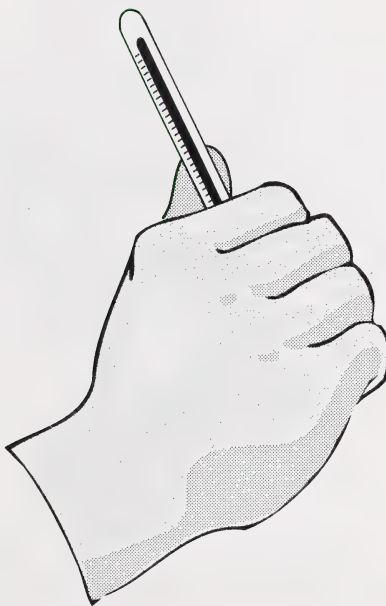
In the activity that follows, you will learn that all living processes are powered by stored chemical energy.

Check your answers by turning to the Appendix, Section 1: Activity 3.

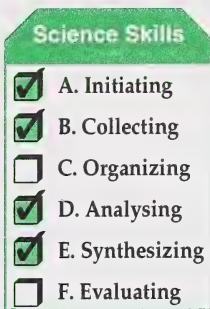
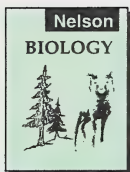
ACTIVITY

4

Cellular Respiration and Energy Loss



Try this simple demonstration. Carefully hold a thermometer such as one from your lab kit in your fist. Don't break it! What happens to the temperature? (It should go up.) This proves that your hand is slightly warmer than room temperature and is losing heat. The heat energy comes from respiration. Can you prove this?



Investigation: Energy Loss During Metabolic Activities

Read carefully the laboratory description on page 54 in your text.

Materials

Use the listed items on page 54 of your text.

You may substitute styrofoam cups for the thermos bottles. They should be set up as shown in Figure 1.3 below.

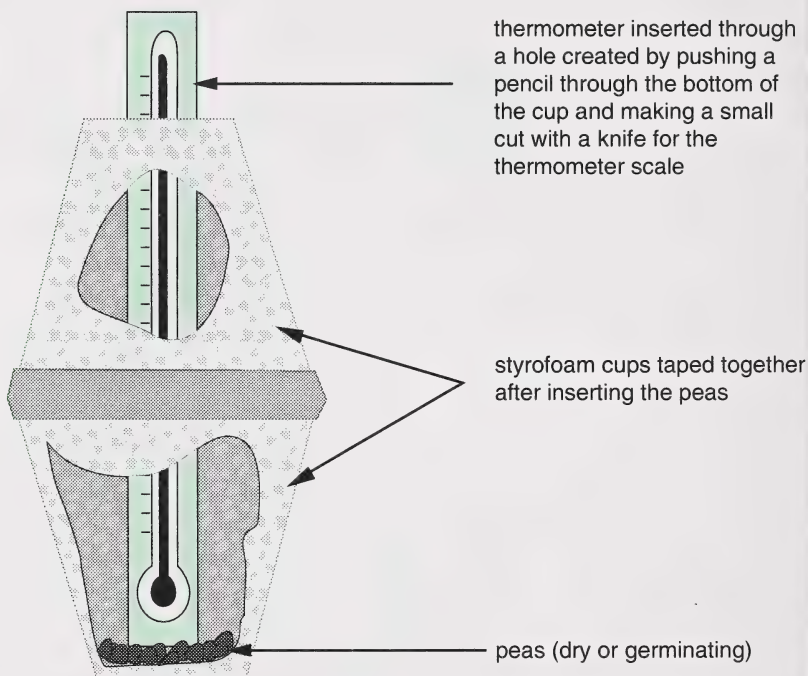


FIGURE 1.3 Alternate Apparatus Set-up

Your kit will only contain 40 seeds, 20 for dry conditions and 20 for germinating conditions.

Procedure

Before following the procedure in the text, answer the questions that follow.

1. What is the function of a control in this investigation?
2. Why are dry seeds used?

Germination is the reawakening of a dormant **embryo** inside the seed. When water is absorbed into a dry seed by soaking it overnight, cellular respiration can once again occur. The embryonic plant can now start to grow.

3. Predict what will happen to the temperature in each apparatus over three days.

Check your answers by turning to the Appendix, Section 1: Activity 4.

Now, follow the procedure outlined on page 54 of your text by setting up your apparatus.

- Try to take readings early in the morning, at noon, and late in the afternoon. This will give you the best results.
- Record your data in Table 1.4.
- When graphing, the manipulated (independent) variable is placed on the horizontal axis.
- The responding (dependent) variable is placed on the vertical axis.
- Take note of step 9 and choose a location for your apparatus carefully.

Analysis and Interpretation

4. How do your predicted results compare to the actual results?
5. How do the results of this investigation explain why harvested grain must be dried before storage?

embryo – an animal or seed plant in an early stage of development

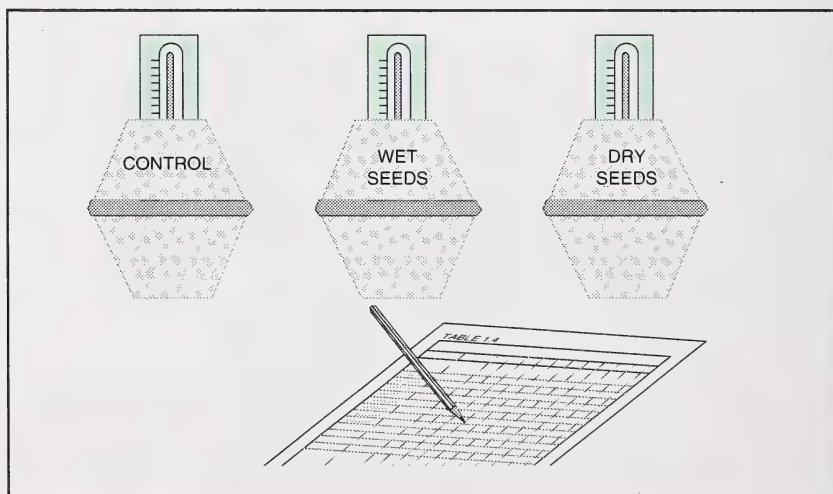
Observations

Construct a chart like the following to record your observations.

TABLE 1.4 Energy Loss During Germination

Reading Number	Day and Time	Time Elapsed (hrs)	Control Temp (°C)	Dry Seed Temp (°C)	Wet Seed Temp (°C)
example	Wednesday, 8:00 am	0	18	18	18
1					
2					
3					

6. If the seeds did not germinate, but there was a distinct rise in temperature, how would you explain this observation?



Check your answers by turning to the Appendix, Section 1: Activity 4.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section, you have traced the flow of energy through the biosphere. Go back and examine the photograph of whitewater rafting in the Section Overview. Imagine yourself in the raft.

1. Why is it hard to stay in the raft?
2. How do you keep from falling out?
3. Where do you get the energy to stay in the raft?
4. If you had bacon and eggs for breakfast before rafting, would you receive as much energy as the same amount of oatmeal? Why is there a difference in energy?
5. How does an oat plant store energy?
6. Ultimately, where does the energy to stay in the raft come from?
7. Using a flow chart, diagram the passage of energy through the biosphere.

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

Do one or more of the following.

1. Try to locate a farm in your area that uses special techniques to improve the efficiency of energy storage. This may be a poultry farm, like the battery farm in the video, or a low-input, regenerative grain farm. Visit the farm to determine how the costs of operation compare to conventional farms. Try to visit a farm that practises deep tillage or zero tillage. Compare efficiency.

2. Collect information about solar radiation and agricultural productivity in Canada. Make a map to show the relationship you discover.
3. How could you improve the energy efficiency of your diet without changing the amount of biomass you eat? Contact a nutritionist at a health clinic.
4. Design a system that would allow you to recycle metabolic heat in your home and save on your heating bill. Compare your system to the Total Heat Recovery system used in some large office buildings.

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

In this section you learned that living things use, transform, and release energy. While the energy originates in the sun, being able to capture and use that energy is the key to life on Earth.

ASSIGNMENT

Turn to the back of this booklet and do the assignment for Section 1.

Cycles of Matter



PHOTO SEARCH LTD.

Whether playing or just watching, everyone seems to enjoy a good hockey game. Hockey is practically a natural part of life in the biosphere at least in North America. Actually hockey is more similar to life in the biosphere than you may realize. Think about it. Lots of energy goes into the game and is eventually lost as heat. Matter (the players) cycles between the ice and the bench.

In this section you will examine the major cycles of matter in the biosphere. You'll study the hydrologic or water cycle including the influence of human activities such as acid rain. The carbon-oxygen, nitrogen, and phosphorus cycles will also be discussed since they are vital to the formation of proteins and energy storage molecules in all living things. Keep in mind that all of these cycles occur because energy flows through the biosphere.

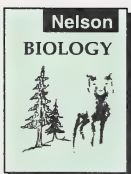
ACTIVITY

1

Hydrologic Cycle



Imagine yourself walking across a searing desert for several days and finally reaching an oasis. For many kilometres all you see is sand, sand, sand! Then suddenly grass and trees and succulent plants appear. The lush vegetation is no mystery. You know the reason – water. And where there is water, there is usually life.



To learn about the importance of water to living organisms, read the section titled The Hydrologic Cycle on pages 31-33 in your text. Answer the questions as you read.

1. How does water help in maintaining relatively stable global temperatures?
2. There are four processes that cycle water in the biosphere. Which two processes are **abiotic** and which two are performed by living organisms?
3. What causes acid rain?

abiotic – characterized by the absence of life; non-living

ecosystem – a living community and its environment



1657

4. List three impacts of acid rain on **ecosystems**.
5. Describe one solution to the problem of acid deposition.

If you have access to the laser videodisc *The Living Textbook* check frame 1657 on side 7 which shows the movement of water about the Earth.

Check your answers by turning to the Appendix, Section 2: Activity 1.



PHOTO SEARCH LTD.

Ah, the joys of winter! Have you ever gotten into your car with your friends on a cold, winter day and had all the windows fog up? Have you noticed that a window also fogs up when you lay it on your lawn on a hot, summer day? These events give evidence that plants and animals lose water to the atmosphere. Obviously, water must be consumed first. A natural balance exists between plants and animals in the "**Biotic** Water Cycle."

biotic – pertaining to life; living

PATHWAYS

If you have access to laboratory facilities, do Part A.
If you do not have access to laboratory facilities, do Part B.

Investigation: Water Loss in Plants

transpiration – the loss of water through the leaves of plants

Objective

In this investigation you will measure the rate of **transpiration** in a plant under different conditions.

Background Information

Water loss occurs as a result of the necessity for gas exchange in plants. Transpiration also cools the leaves much the same way sweating cools you.

A potometer is used to measure the rate of water loss from plants. When using this device it is assumed that the rate of water loss is the same as the rate of water uptake by the stem.

Part A

Materials

- balance
- razor blade
- plant with leaves (e.g., tomato)
- pipette
- rubber tubing
- wire
- water
- fan
- ring stand and clamps

Procedure

- Place the plant in water and cut off the stem below the water with a razor blade.
- Fill the pipette and tubing completely with water and dislodge any trapped air.
- Insert the stem of the plant into the tubing and secure them together with wire.
- Support the plant and pipette as shown in Figure 1.4 in a warm place.



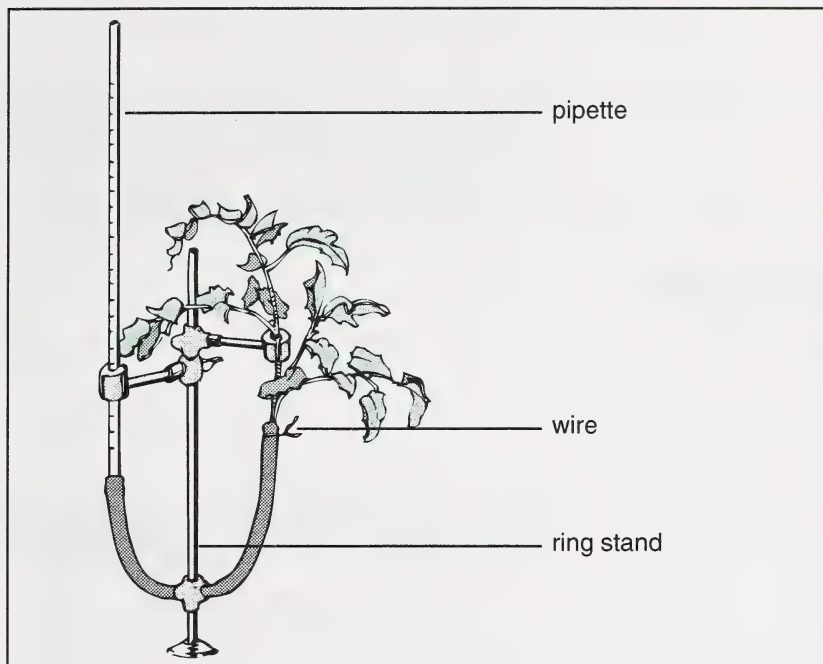


FIGURE 1.4 Simple Potometer

Caution

- Allow 5 minutes before starting to make sure the water level in the pipette is changing. If it is not, set up the apparatus again and be careful to remove any air bubbles in the tubing or stem.
- Record the initial level of water in the pipette in Table 1.5 and take readings every 5 minutes for 20 minutes.

oscillate – to swing or sway back and forth

- Repeat the previous step after putting an **oscillating** fan about 1 metre from the plant. Do not allow sufficient direct wind to damage the leaves. Be careful with the fan.
- Dismantle the apparatus and put the equipment away.
- Weigh the plant and calculate the rate of water loss in Table 1.6 for the warm place and with the fan.

Observations

TABLE 1.5 Water Loss in Plants

Time Elapsed (min)	Pipette Reading (mL)		Change in Volume (mL)	
	Warm	Warm and Fan	Warm	Warm and Fan
0			0	0
5				
10				
15				
20				

Science Skills

☒

A. Initiating

☒

B. Collecting

☒

C. Organizing

☒

D. Analysing

☐

E. Synthesizing

☐

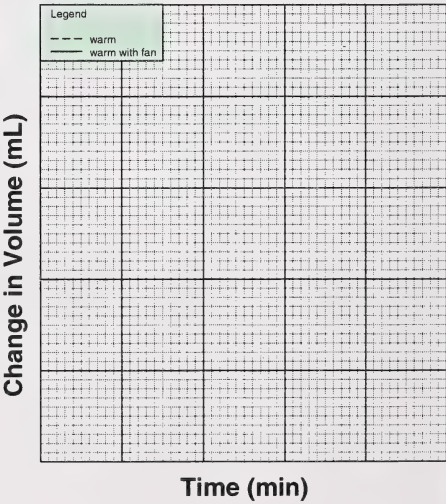
F. Evaluating

TABLE 1.6 Calculation of Rate of Water Loss

	Warm	Warm and Fan
A. Total volume of water lost (mL)		
B. Total time elapsed (min)	20	20
C. Average rate of water loss (mL/min) A÷B		
D. Mass of plant (g)		
E. Rate of water loss (mL/min/g) C÷D		

Analysis and Interpretation

6. Use your own graph paper to graph the data collected in Table 1.6 to compare the change in volume over time. Use the legend to show both conditions. Look at the example to see how to set up your graph. Title your graph Graph 1.6 Water Loss in Plants.



7. What is the advantage of doing this investigation in a warm place?
8. Explain why there is a difference in the rates between the warm location and the addition of the fan. If you were unable to use two different location, make a prediction.
9. List two other factors that might affect your results in this investigation. Explain the effect of each factor.

Part B

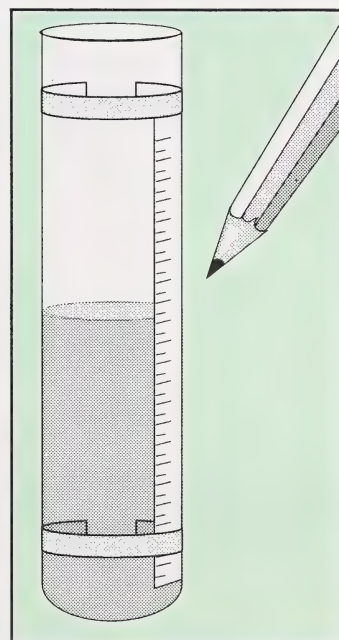
Materials

- balance beam scale
- plant with leaves (e.g., tomato)*
- test tube
- cotton ball
- test tube rack
- masking tape
- 10 mL graduated cylinder
- fan (optional)
- paper*
- scissors*
- metric ruler

* supplied by student

Procedure

- Cut a strip of paper 1 cm wide and 12 cm long. Tape the strip of paper to the side of the test tube. This strip will become a scale.
- Add 10 mL of water to the graduated cylinder. Pour the water 1 mL at a time into the test tube and mark the level of the water each time on the paper strip. You may wish to add half millilitre marks later.
- Add water up to 20 mL and mark this level on your scale. You now have a calibrated test tube.
- Carefully cut the plant stem as described in Part A and insert the stem in your test tube.



- Hold the stem in place by packing the cotton ball around the inside of the tube near the top. This will also seal the tube and slow evaporation. Do not let the cotton touch the water.
- Carefully stand the test tube in a 250 mL beaker or other suitable container so it will not tip over.
- Follow the rest of the procedure in Part A to collect data and complete Table 1.5, Table 1.6 and Graph 1.6.
- If you do not have access to a fan consider testing water loss in a warm versus a cool location.
- Do Analysis question 6 from Part A.



Check your answers by turning to the Appendix, Section 2: Activity 1.

soluble – something that can be dissolved in a liquid (usually water)

As you have read, the water cycle is closely related to the cycling of other **soluble** substances. In the next activity, you will learn about two other important elements in the biosphere.

ACTIVITY

2

Carbon-Oxygen Cycle

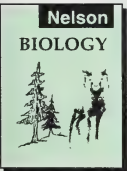


Have you ever sat with friends around a campfire and noticed that every eye seems glued to the fire as the flames dance and lick the air? Humans seem fascinated by fire. You might recall from previous science courses that flames are really hot particles of carbon and that heat comes from the combustion of carbon in oxygen. Although a campfire is not alive, it does need oxygen just like a living thing and it is a good example of a carbon-oxygen cycle.

To learn about this essential cycle of matter, read pages 34-37 in your text and answer the following questions.

1. What complementary biotic processes form the integral loop in this cycle? How does each process affect the amount of carbon in the atmosphere?
2. Explain the value of fossil fuels relative to the carbon cycle.
3. Construct a chart using the following headings:

Processes that increase CO_2	Processes that decrease CO_2
---------------------------------------	---------------------------------------



4. Explain how the Earth's atmosphere produces a greenhouse effect.
5. Predict the effect of increasing the amount of greenhouse gases in the atmosphere through human activities like burning fossil fuels.

Hint: Check Figure 1.16 on page 35 and read through pages 36 and 37.

6. How might this increase in greenhouse gases affect the hydrologic cycle?

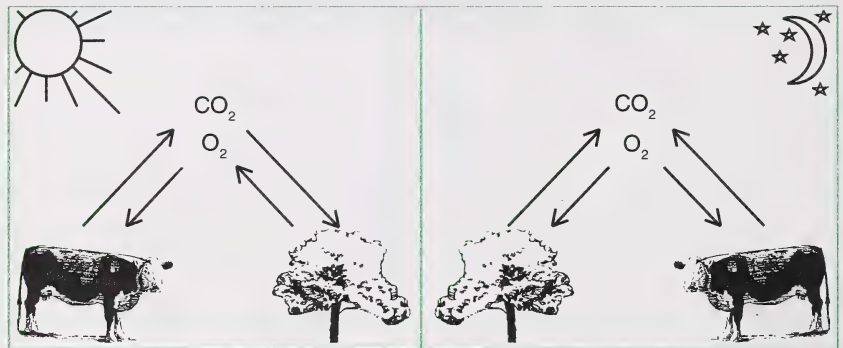
If you have access to the laser videodisc *The Living Textbook* watch the short movie in chapter 35 on changes in global temperatures. This is on side 8.



23229

Check your answers by turning to the Appendix, Section 2: Activity 2.

You will learn more about the impact of humans on the biogeochemical cycles in Section 3.



It is important to remember that living organisms play a vital role in the carbon-oxygen cycle. In Section 1, you learned that photosynthesis occurs in light and takes CO_2 out of the air. Cellular respiration occurs all the time in plants and animals and puts CO_2 back into the atmosphere.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

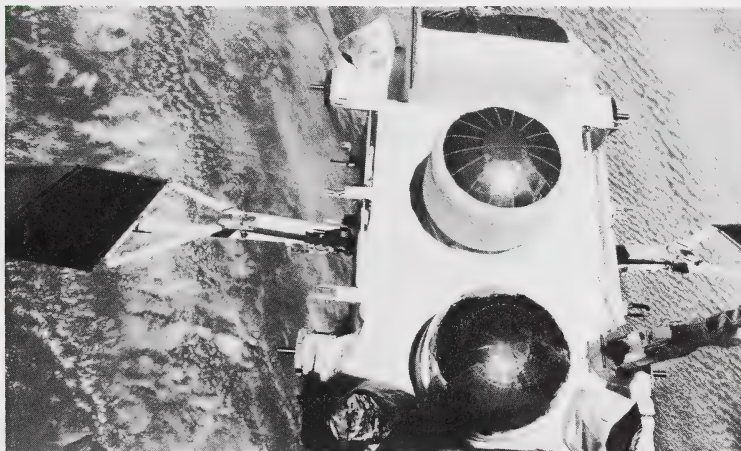
Investigation: CO₂ Production in Plants And Animals

Objective

You will design an experiment that compares the production of CO₂ in plants and animals over a 24 hour period.

Background Information

A space station orbiting the earth enjoys 20 hours of daylight and 4 hours of darkness. In its greenhouse, the plants provide the oxygen supply for the astronauts. Each gram of plant produces 10 mL of O₂ during every hour of light and consumes 5 mL of O₂ during every hour of darkness. Each gram of astronaut in the space station utilizes 5 mL of O₂ during every hour of the day. Make a table of this data for your own reference.



NASA

If the carbon-oxygen cycle is perfectly balanced, the astronauts can be supported by 1 000 000 g of greenhouse plants.

Prediction

7. Calculate the amount (mL) of CO₂ produced in one day by the plants and astronauts. (During photosynthesis O₂ production = CO₂ consumption.)
8. How much CO₂ is produced by the plants during the 4 hours of darkness?
9. Assuming a balance of gases is maintained, determine the mass of the astronauts.

Procedure

10. Design a possible test for your prediction that could be done on Earth.

Before you check your design, have you remembered to collect the gases from a photosynthesizing plant, a respiring plant, and a respiring animal?

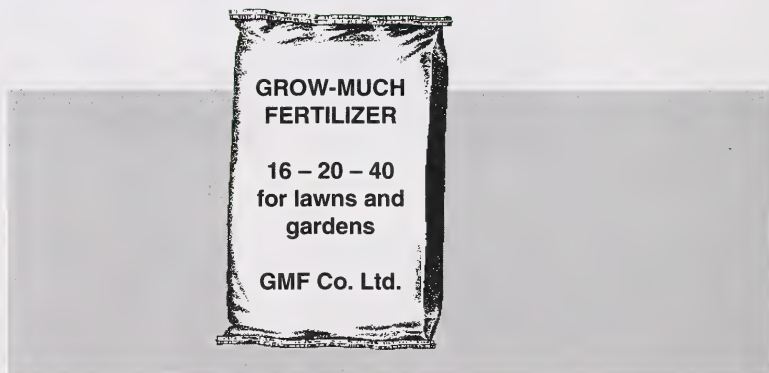
Check your answers by turning to the Appendix, Section 2: Activity 2.

Proteins and nucleic acids are important organic molecules. Most of these molecules are made of carbon, hydrogen, and oxygen. However, there are two more elements that must be available to living organisms before proteins and nucleic acids can be synthesized. Besides carbon, hydrogen, and oxygen, these elements must also cycle in the biosphere and be shared amongst living things.

ACTIVITY

3

Nitrogen and Phosphorus Cycles



What do the numbers on the fertilizer bag mean? Are they the combination to the "growth bank" lock? Are they the price of the bag in Canadian dollars, U.S. dollars, and Mexican pesos? Why use fertilizer at all?

In this activity, you will learn about the nitrogen and phosphorus cycles and how the use of fertilizers has influenced agriculture and the biosphere.

Nelson

BIOLOGY



Read pages 38-40 in your text and answer the questions that follow.

1. What are nitrates?
2. Describe the abiotic and biotic processes that convert atmospheric nitrogen into nitrates.
3. How do denitrifying bacteria affect your lawn?
4. Why is it a good idea to plant legumes in your garden each year?
5. What are phosphates?
6. Explain the difference between the long-term and the short-term phosphorus cycle.
7. How have humans influenced the nitrogen and phosphorus cycles positively?

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☒ F. Evaluating

Check your answers by turning to the Appendix, Section 2: Activity 3.

Human activities have greatly disrupted the nitrogen and phosphorus cycles through the impact of fertilizers and detergents.

If you have access to the video *Water in Alberta: The Living Flow*, view parts 1 and 2 to increase your understanding of the importance of water and the impact of human activities.

If you do not have access to this video refer to Agriculture and the Nitrogen and Phosphorus Cycles on pages 40 in your text and answer the following questions.

8. Predict the long-term effect of excessive fertilizer and detergent use on the nitrogen and phosphorus cycles.
9. Describe some possible solutions to the problem created by fertilizer and detergent pollution.

Check your answers by turning to the Appendix, Section 2: Activity 3.

Nelson

BIOLOGY





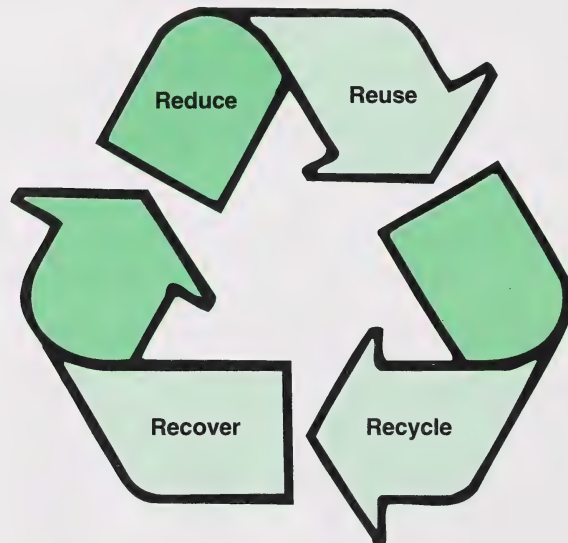
1656

As you have learned, human activity can alter the balance of biogeochemical cycles. In an attempt to improve agriculture and sanitation, the use of technology has polluted the biosphere and disrupted carbon, nitrogen, and phosphorus cycles. Even the hydrologic cycle is threatened.

If you have access to the laser videodisc *The Living Textbook* select frame 1656 in lesson 7.2 Ecosystem Dynamics. This is on side 7 and shows these five major cycles. Note that all the cycles are powered by solar energy.

The 4Rs to a healthy biosphere

The biogeochemical cycling of matter is essentially a definition of life. Unfortunately it can be influenced by humans. To make certain that the water, carbon, oxygen, nitrogen, and phosphorus cycles remain balanced, humans must follow a four-step process.



10. How can these four steps help to maintain a balance in the biogeochemical cycles?
11. List three places you have seen this symbol.

Check your answers by turning to the Appendix, Section 2: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

This section recognizes some of the cycles of matter that occur in the biosphere. The major cycles are water, carbon-oxygen, nitrogen, and phosphorus. Each cycle is driven by energy and includes biotic and abiotic components.

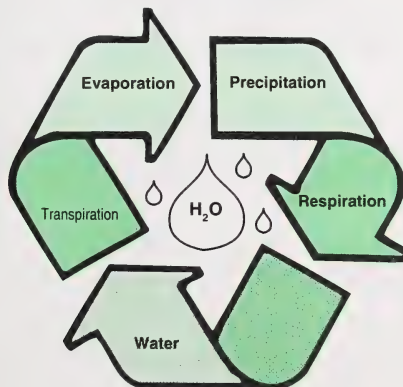
The Hydrologic Cycle

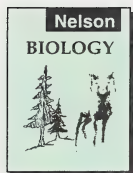
How important is water to the biosphere? To answer this question, watch the video *Water: A Fascinating Liquid*. Familiarize yourself with the following questions first. As you view the video answer the questions. Stop the tape whenever necessary.

If you do not have access to this video study page 31 in your text. Pay particular attention to Figure 1.12 and Table 1.5.

1. Describe the two major processes that cause water to cycle on the Earth.
2. When water freezes it turns to ice. This could be a serious problem for aquatic organisms. Fortunately ice floats. Why?
3. How important is the water cycle to the biosphere?

The hydrologic cycle also involves transpiration from plants and respiration from plants and animals.

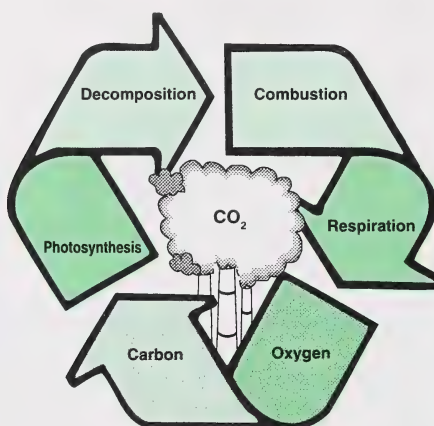




The Carbon-Oxygen Cycle

This cycle is very closely tied to plant photosynthesis and animal respiration. From your reading about the biogeochemical cycles on pages 34-37 in your text, answer the following questions.

4. Write the chemical formula for photosynthesis.
5. Where does CO_2 come from?
6. Write the chemical formula for respiration.
7. Where does the CO_2 go?

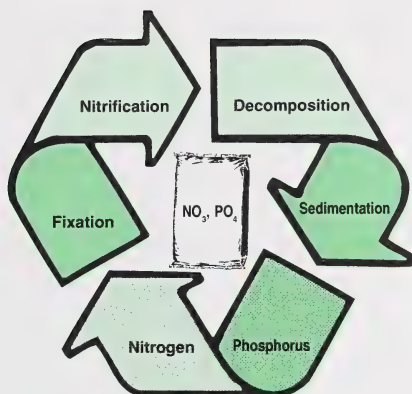


The decomposition of organic material and the combustion of fossil fuels add CO_2 to the atmosphere at an increasing rate.

8. What effect does this have on the carbon-oxygen cycle?

The Nitrogen and Phosphorus Cycles

The role of plants in these cycles is critical. Nitrates and phosphates in the soil easily dissolve in water. As water is absorbed by the roots, these nutrients are incorporated as proteins and nucleic acids in the plant.



From your reading about these cycles on pages 38-40 in your text, answer the following questions.

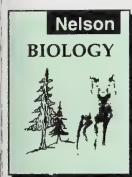
9. What role is accomplished by ammonification and nitrification bacteria?
10. Why are phosphates important to living organisms?
11. How have humans influenced the nitrogen and phosphorus cycles?

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Do one or more of the following.

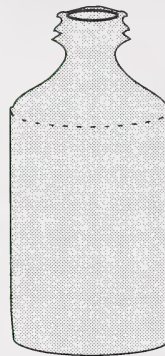
1. Learn about the solid waste management program in your community by visiting your local sanitation, public works, or environmental resource authorities.
2. Design an experiment to test the effect of chemical fertilizers on the growth of plants and animals. Use fertilizers with different NPK numbers to determine what each nutrient will do.
3. Find out from a local hospital or physician how to measure human water balance. What practical value does this knowledge have in your daily use of water?
4. Research the problems encountered in the biosphere when fossil fuels are the primary source of energy in a community.



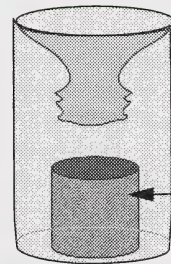
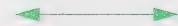
5. Set up a rain gauge in an open area near where you live to monitor precipitation over a two week period. Directions for making a simple home-made rain gauge follow. Compare your results to those from the local Weather Office and see how precipitation is distributed throughout the year in your community. From this research you will understand how the water cycle affects life in your community.

Homemade Rain Gauge

2 L Plastic pop bottle



Measure diameter



Collection cup

Invert top portion and place inside bottom portion

10 mL graduated cylinder



Find the Collection Area:

- Measure diameter of bottle
- $\frac{\text{Diameter}}{2} = \text{radius}$
- $\text{area} = \pi r^2$
($\pi = 3.14$)

After a rainfall pour water from collection cup into graduated cylinder. Calculate mL rain per area.



Courtesy of Vern Koesling

The importance of reusing raw materials can help eliminate what you see in the preceding photograph. The National Geographic video, *Recycling: The Endless Circle*, illustrates this process. If you have access to this video try this next enrichment activity. Familiarize yourself with the following questions. As you view the video answer the questions. Stop the tape whenever necessary.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☒ F. Evaluating

6. Summarize the three-step process by which humans produce garbage.
7. What is wrong with this process?
8. Why is garbage burned at the Babylon Resource Recovery Facility?
9. Describe how aluminum cans are recycled.
10. What is the "price to pay" if the amount of garbage is not reduced?
11. Name a few examples of how humans reuse products.
12. Since only about 15% of waste is being recycled, there is much that can be done. Use personal examples to tell what can be done at home and at school to reduce, reuse, recycle, and recover.

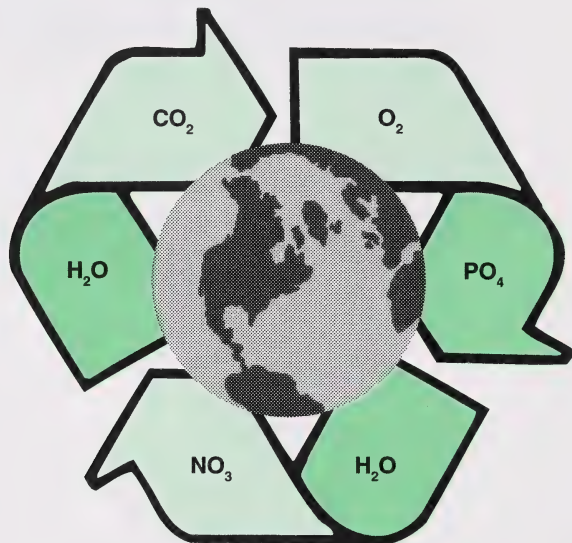
Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

In this section you learned that water, carbon, oxygen, nitrogen, and phosphorus cycle in the biosphere. Sometimes these compounds are part of the nonliving or abiotic Earth. Other times these compounds are an essential part of living things.

Human activities can influence these important cycles by unnaturally increasing or decreasing components.

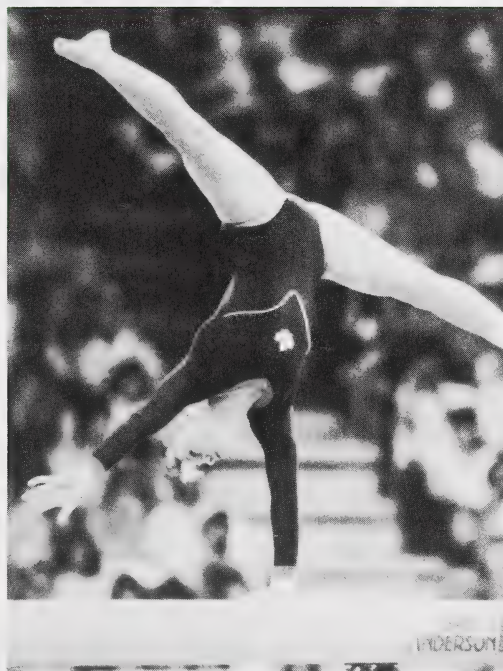
It is easy to accept that life needs energy, but it must also be recognized that life on Earth also requires a continuous cycle of matter.



ASSIGNMENT

Turn to the back of this booklet and do the assignment for Section 2.

Nature's Balance



WESTFILE INC.

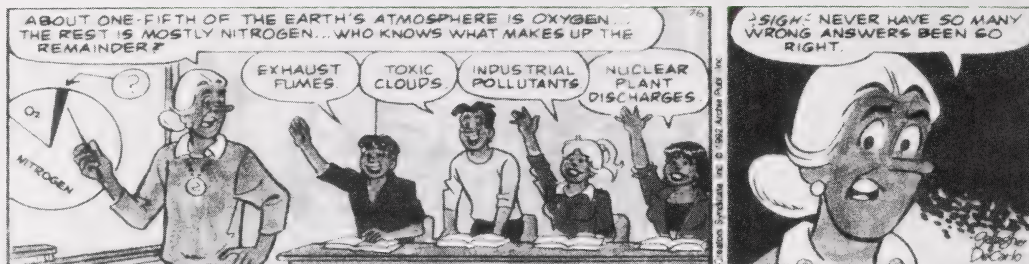
Have you ever tried walking along the top of a fence? Maybe you have had to inch your way along a narrow ledge while hiking in the mountains. Have you balanced a broom on the tip of your finger? Maybe you have gone surfing, sailboarding, or skateboarding. All of these activities require precise movements and a good sense of balance. If you make a mistake, then you fall. Of course, it would be easiest on your body if you always maintained your balance.

In this section, you will learn about the Earth's balancing act and the effect of things like ozone depletion and global warming. Since human activities may cause a fall, humans must help the Earth maintain its balance. After all, the Earth's future is also your future!

ACTIVITY

1

Is There A Balance?



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What ever happened to the “balance of nature”? With all the pollution in the air, soil, and water, is it any wonder that you may feel that there is no balance in nature?

On the other hand, you may not be too concerned about the environment. After all, have you ever been evacuated from your home because of a toxic waste spill? Have there been any earthquakes in your back yard moving rivers and destroying wildlife **habitat**. Have you gone without food for weeks because of a multi-year famine in your part of the province? These events are not common in Alberta, but they do occur almost daily somewhere on Earth.

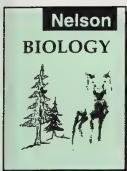
habitat – the place where a plant or animal lives naturally

Unlike any single organism, the biosphere is very big. But like any single organism, life in the biosphere is fragile. Use what you have learned in the first two sections to answer the following questions.

1. What laws describe a balance of energy input to energy output in the biosphere? Explain your answer.
2. Is there a balance in the cycling of matter? How do humans affect this balance?

In the following investigation, you will determine what is necessary for a **steady state equilibrium** to exist in the biosphere.

steady state equilibrium – a condition in which adjustments to change produce a constancy



As background information, read pages 20-21 in your text and answer the following questions.

3. What is a closed system?
4. How is the Gaia hypothesis accurate?
5. Who has the greatest impact on the constancy within the biosphere?

Check your answers by turning to the Appendix, Section 3: Activity 1.

PATHWAYS

If you have access to laboratory facilities, do Part A.
If you do not have access to laboratory facilities, do Part B.

Part A

Investigation: A Closed Biological System

Objective

You can create a closed biological system to show that a balance can be maintained between biotic and abiotic factors.

Note: You must supply the following materials for yourself. They are not part of your course lab kit.

Materials

- large bottle or jar (3-4 L) with lid
- light source (60 W bulb)
- a plant-eating fish
- aquatic plants (5-6)
- small pond snails (2-4)
- clean gravel or sand
- dechlorinated water (tap water left standing in an open, clean jar overnight)

Science Skills

- ☒ A. Initiating
- ☒ B. Collecting
- ☒ C. Organizing
- ☐ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

Procedure

6. Design an experiment to meet the objective. Use the materials listed and outline the steps to follow. This system should function for a month with daily observations. Write your procedure for setting up the materials.
7. Why should an airspace be left in the container?

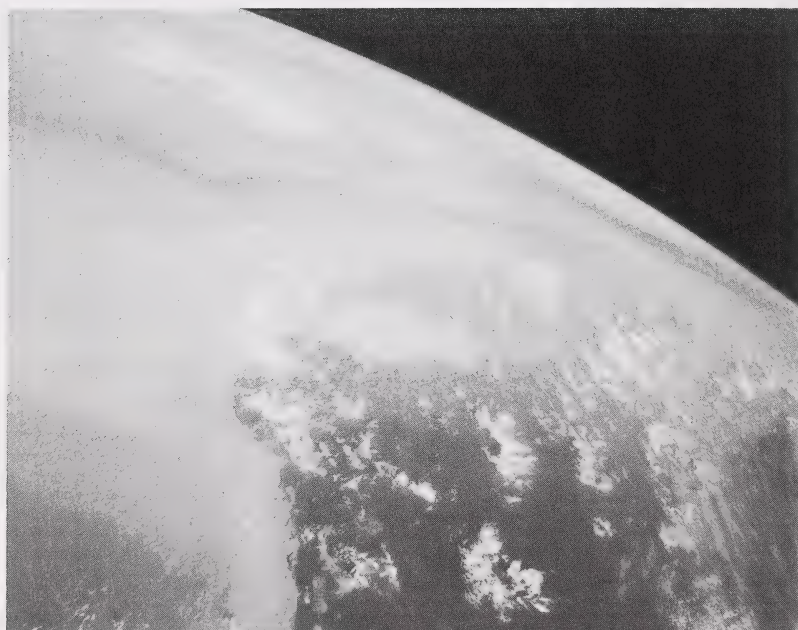
Observations

8. A healthy system has a pale green colour caused by algae. How would moving the light source closer affect the colour?

Analysis and Interpretation

9. Describe how a steady state equilibrium is maintained in the jar.
10. How can this balance be disrupted?

Check your answers by turning to the Appendix, Section 3: Activity 1.



NASA

Part B

Watch the video *Creatures of the Pond*. Imagine trying to recreate the pond in a jar or aquarium with a tight lid. Got the whole picture? Go back to Part A and answer questions 7 to 10.

This investigation shows that a closed system could continue for a long time as long as light is available. The biosphere is a closed system too. In the next two activities, you will learn more about two major disruptions to a balance in the atmosphere.

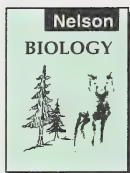
ACTIVITY

2 What About Ozone Depletion?



PHOTO SEARCH LTD.

Ahhh, summer! Those lazy days of fun in the sun. No school, no worries, no deadlines, only lots of time and lots of rays! Have you ever wanted summer to last ten months instead of two? Maybe you want to move to Australia or Hawaii to fulfill your dreams of a leisure-filled life. There are only two significant problems – money and ozone depletion.



Completing high school successfully will give you a headstart on solving the money problem, but what about the ozone problem? Are ultraviolet rays from the sun really absorbed by the ozone layer? Will a decrease in ozone lead to an increase in skin cancer?

To learn more about this global issue, read pages 22-24 in your text and answer the following questions.

1. What is ozone? Where is it found?
2. Why is this gas so important?
3. What seems to be the cause of an ozone depletion in the atmosphere?

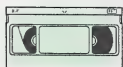
Check your answers by turning to the Appendix, Section 3: Activity 2.

The extent of the problem of ozone depletion is only now becoming known.

PATHWAYS

If you have access to the video *Planet Under Pressure: Ozone*, do Part A.
If you do not have access to this video, do Part B.

Part A



Familiarize yourself with the following questions, then watch the video. Answer the questions as you watch the video. Stop the tape whenever necessary.

Part B

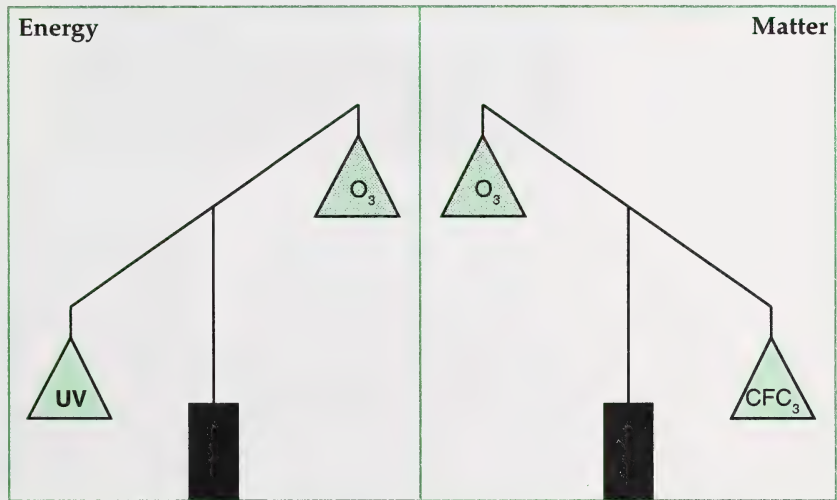
Answer questions 6 and 7 using information from pages 23 and 24 in your text.

4. What was the "genie in the bottle" that made so many dreams come true?
5. What happens to this "genie" when it is released into the air and reaches the stratosphere?

6. Where is the greatest amount of ozone produced? Why?
7. What are the long-term impacts of an ozone depletion on living organisms? Describe an effect on humans and an effect on plants.
8. Describe the new "ozone friendly genie" that may help reduce the problem.

So, what about the ozone depletion?

The current picture looks like this!



9. What must be done to restore a balance of energy and matter?

Check your answer by turning to the Appendix, Section 3: Activity 2.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

ACTIVITY

3

Will Global Warming Continue?



ATMOSPHERIC ENVIRONMENT SERVICE
ENVIRONMENT CANADA



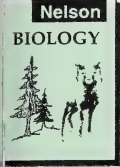
RYCROFT SIGNA

Everybody talks about the weather, but nobody does anything about it – or do they? Have you wondered why there seems to be more hurricanes and tornadoes in the news? Ever noticed that flooding and droughts are more common in the last few years? Have you thought about the changes in climate of your region? Are humans the cause of all these changes? Global warming may be the reason that there are some major changes in climate being experienced around the Earth. So what is global warming and how does it happen?

You've studied the hydrologic cycle and the greenhouse effect and recognize the power of heat energy in the biosphere. But can there be too much heat? The answer is yes and the problem is global warming.



To help you understand this phenomenon watch the video *Global Warming, Hot Times Ahead*.



Construct a chart like the following example. Then as you watch the video fill in both columns of your chart. Before you decide global warming is all bad read the Point – Counterpoint discussion on page 42 in your text.

Human activities that increase greenhouse gases	Human activities that decrease global warming

Science Skills

- ☐ A. Initiating
- ☒ B. Collecting
- ☒ C. Organizing
- ☐ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating



The future of global warming is yours. Are your hands tied? What can you do? How can one person make a difference?

Check your answers by turning to the Appendix, Section 3: Activity 3.

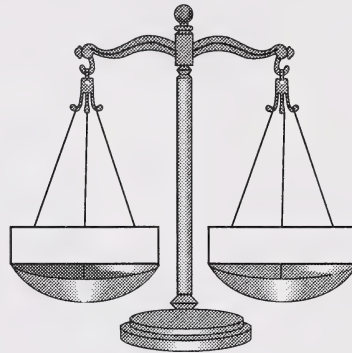
Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you have learned that there is an extraordinary balance of energy and matter that makes life possible in the biosphere.

1. Label the scale with the names of the two biological processes that maintain a balance of gases in the atmosphere.



Unfortunately, human activities have disrupted this delicate balance. As the composition of the atmosphere changes, there is great concern for the effect on the biosphere.



PHOTO SEARCH LTD.

2. Several compounds make up the important greenhouse gases. Using the terms in the word list below, complete each of the following statements. Refer back to your text if necessary.

Word List

CFC

 CO_2 N_2O CH_4

global warming

 O_2 H_2O O_3 N_2

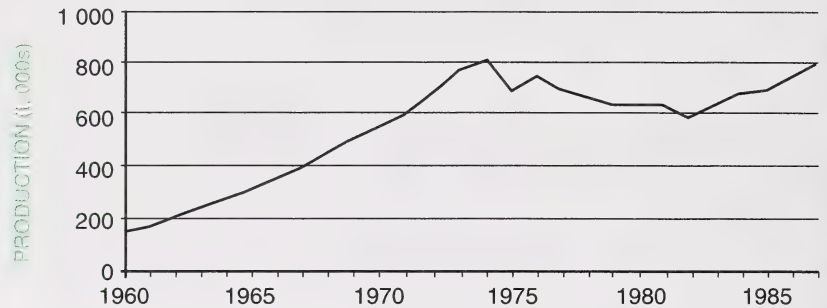
ozone depletion

- a. The most abundant greenhouse gas is _____.
- b. During photosynthesis _____ gas is produced.
- c. _____ is used to make plastic foams and refrigerator coolant.
- d. A buildup of greenhouse gases causes _____.
- e. The most abundant gas in the atmosphere is _____.
- f. _____ is a product of bacterial decay.
- g. Heat is trapped in the atmosphere when _____ forms around CO_2 .
- h. The breakdown of CFC by ultraviolet radiation causes _____.
- i. _____ is a greenhouse gas produced from animal wastes as well as fertilizers.
- j. _____ protects the earth from ultraviolet radiation.

One of the major disruptions to the atmosphere caused by human activity is ozone depletion. Graphs 1.7 and 1.8 show the relationship between this human activity and the atmosphere.

GRAPH 1.7 Global production of the most common CFCs 1960-87

The world production of CFCs increased in the mid-1980s, after a decline in the middle and late 1970s, when their use in spray cans was restricted. The developed world makes and consumes 80% of all CFCs. Canada's contribution is 3%.

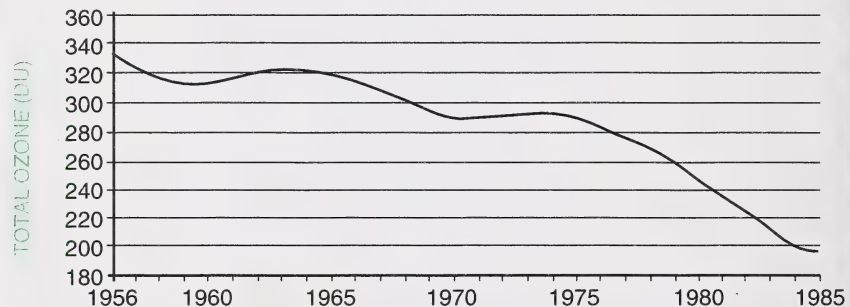


Source: Chemical Manufacturers Association (1988).

3. What is the major source of CFCs today?

Hint: It helps explain why there has been an increase since 1981.

GRAPH 1.8 Total ozone values over Antarctica, 1956-85



Note: Measurements of total ozone amounts over Halley Bay in the Antarctic during the southern spring have shown a 40% decline between 1956 and 1985. the curve represents the smoothed average of the annual measurements.

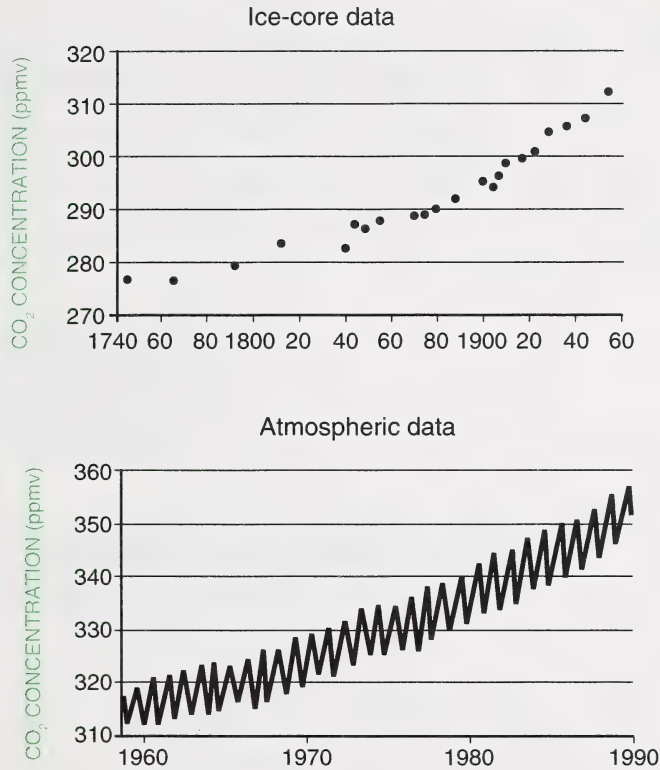
Source: United Nations Environment Programme (1987).

4. Why did ozone depletion appear to stop between 1970 and 1975?

Hint: Compare the two graphs.

The other major disruption to the atmosphere caused by human activities is global warming. Graphs 1.9 and 1.10 show the relationship between these human activities and the atmosphere.

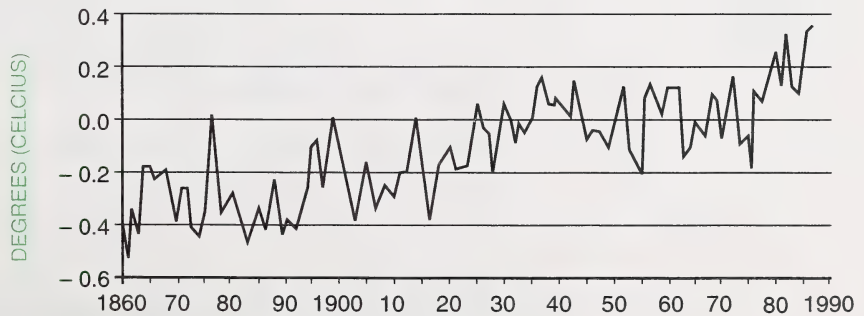
GRAPH 1.9 Variation of atmospheric carbon dioxide concentrations during the past 200-400 years



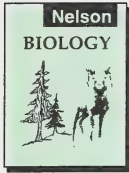
5. What human activities have caused a increase in CO₂ levels since 1840?

GRAPH 1.10 Variation of global mean surface air temperature since 1861

Values shown are departures of annual means from 1950-79 reference period mean.



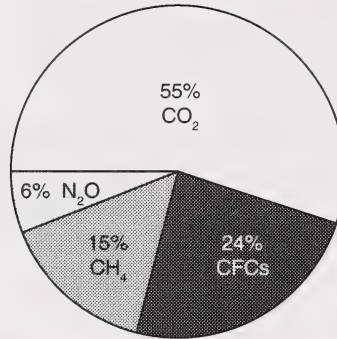
Source: Jones and Wigley (1990).



6. Why has global warming appeared to increase since 1860?

Hint: Compare the two graphs.

7. Use Table 1.6 on page 35 in your text to complete the following pie graph by filling in the source of each greenhouse gas.



Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

Do one or more of the following.

1. Prepare a collage of newspaper articles that shows how the steady state equilibrium of the atmosphere is influenced by human activity.
2. Hold a debate on the issue of increased global warming affecting climate adversely. Prepare both sides of the debate through research. Check Point/Counterpoint on page 42 in your text.
3. Write your Member of Parliament to request information about Canada's Green Plan for a healthy environment. Find out what the government is doing to protect the ozone layer.
4. Obtain a copy of the report *Climate Warming? Exploring the Answers* from the Environment Council of Alberta. Help to develop a clean air strategy for your area from the recommendations given in this report.

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

In this section you studied a closed biological system where energy could enter but matter could only cycle, neither entering nor escaping. The Earth is such a system. You also studied two major threats to the balance of matter on Earth – ozone depletion and global warming. These events are the result of human activities and may affect all life in the biosphere including yours. Hopefully, what you have learned will help you make responsible decisions about your future. Applying what you have learned can help make the biosphere healthy once again. Your hands are not tied. You can make a difference!

ASSIGNMENT

Turn to the back of this booklet and do the assignment for Section 3.

MODULE SUMMARY

In this module, you have learned what makes the Earth suitable for life – and what does not. A constant flow of solar radiation drives the biogeochemical cycles. There is a natural balance that exists in the biosphere. It is not realized that human activities can disrupt it. Fortunately, you and others can restore the steady state equilibrium that will keep life upon the Earth for many years to come.

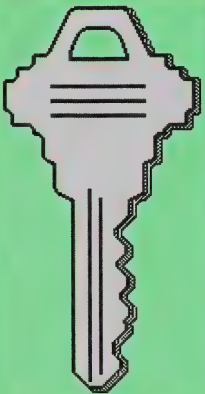
Ensure all the following items have been completed and checked off before leaving this module:

- ☐ Section 1 Assignment
- ☐ Section 2 Assignment
- ☐ Section 3 Assignment
- ☐ All your response pages are numbered and identified with

Biology 20 – Module 1 Section # Assignment Page # Name and ID Number



Appendix

	Glossary
	Science Skills
	Activities
	Extra Help
	Enrichment



MODULE

1

Glossary

abiotic: characterized by the absence of life; non-living

albedo: the reflectivity of a material

battery farm: place where artificial conditions exist

biomass: the dry weight of living organisms

biotic: pertaining to life; living

ecosystem: a living community and its environment

embryo: an animal or seed plant in an early stage of development

entropy: a measure of non-usable energy in a system

habitat: the place where a plant or animal lives naturally

oscillate: to swing or sway back and forth

soluble: something that can be dissolved in a liquid (usually water)

steady state equilibrium: a condition in which adjustments to change produce a constancy

transpiration: the loss of water through the leaves of plants

UV: ultraviolet radiation

A FRAMEWORK FOR SCIENTIFIC PROBLEM-SOLVING SKILLS

A. Initiating and Planning

- identify and clearly state the problem or issue to be investigated
- differentiate between relevant and irrelevant data or information
- assemble and record background information
- identify all variables and controls
- identify materials and apparatus required
- formulate questions, hypotheses and/or predictions to guide research
- design and/or describe a plan for research or to solve the problem
- prepare required observation charts or diagrams

B. Collecting and Recording

- carry out and modify the procedure if necessary
- organize and correctly use apparatus and materials to collect reliable experimental data
- accurately observe, gather and record information or data according to safety regulations (e.g., WHMIS) and environmental considerations

C. Organizing and Communicating

- organize and present data in a concise and effective form (themes, groups, tables, graphs, flow charts, and Venn diagrams)
- communicate data more effectively, using mathematical and statistical calculations where necessary
- express measured and calculated quantities to the appropriate number of significant digits and use appropriate SI units for all quantities

D. Analysing

- analyse data and information for trends, patterns, relationships, reliability, and accuracy
- identify and discuss sources of error and their effect on results
- identify assumptions, attributes, bias, claims, or reasons
- identify main ideas

E. Connecting, Synthesizing and Integrating

- predict from data or information
- formulate further testable hypotheses supported by the knowledge and understanding generated
- identify alternatives for consideration
- propose and explain interpretations or conclusions
- develop theoretical explanations
- relate the data to laws, principles, models, or theories identified in background information
- answer the problem investigated
- summarize and communicate finding
- decide on a course of action

F. Evaluating the Process or Outcomes

- establish criteria to judge data or information
- consider consequences and perspectives
- identify limitation of the data, and information, interpretations, or conclusions as a result of the experimental/research/project/design, processes, or methods used
- suggest alternatives and consider improvements to experimental technique and design
- evaluate and assess ideas, information and alternatives

CRITERIA FOR ASSESSING SCIENTIFIC PROBLEM-SOLVING SKILLS

A. INITIATING AND PLANNING

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Proposes a simple problem statement when initiated to do so	Proposes a simple problem statement	Proposes a problem to be investigated	Clearly states the purposes and problem to be investigated
Background information must be supplied	Background information is supplied from teacher or student's own experience	Background supplied by teacher, reference material, or student's own experience	Prepares the necessary background information from references, research, discussion, and/or past experience
Identifies those things that change and those that stay the same	Identifies variables and controls	Identifies controls, manipulated variables, and responding variables	Identifies the controls and variables
Guesses about the outcomes	Makes 'educated' guesses	Makes a prediction and/or suggests a simple hypothesis	- Forms an appropriate hypothesis and prediction - Designs an investigation
Identifies simple materials and equipment to be used	- Identifies materials and equipment to be used - Is able to assemble simple apparatus	- Identifies the materials and equipment to be used - Assembles simple apparatus	- Identifies and names the materials and equipment to be used - Assembles and designs or modifies simple apparatus
Follows directions as provided	- Follows directions as provided - Is able to write simple procedural statements	Develops and organizes a simple written procedure	Designs and writes descriptions of procedures that are clear and detailed
	Prepares observation charts, tables, and diagrams as directed by teacher	- Prepares observation charts, tables, diagrams, graphs - Performs calculations as outlined by teacher	- Prepares observation charts, diagrams, and graphs - Performs necessary calculations

CRITERIA FOR ASSESSING SCIENTIFIC PROBLEM-SOLVING SKILLS

B. COLLECTING AND RECORDING

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Follows a simple procedure	Follows a simple procedure	Follows a given procedure and is able to suggest modifications when asked to do so	Follows a given procedure and modifies the procedure when necessary
Correctly uses apparatus and materials as directed by teacher	Correctly uses apparatus and materials with little teacher assistance	Correctly uses apparatus and materials with infrequent modification	Consistently uses standard apparatus and materials correctly
Collects data using concrete, tangible objects	- Collects tangible objects - Carries out simple measurements	Accurately collects data	Accurately collects relevant data
Records data in sentence form or in simple charts that have been constructed	- Records data in numerical and non-numerical form - Is able to use and construct simple charts	Record relevant data including the correct units with respect to measured data	Records relevant data using the appropriate units
- Is aware of safety and environmental concerns - Follows stated safety procedures	- Is aware of safety and environmental concerns - Follows stated safety procedures	Shows appropriate safety and environmental concerns in the use, care, and maintenance of materials and apparatus	Demonstrates appropriate standards of safety
		- Is able to locate appropriate safety regulations - Actively participates in teacher-directed discussion of safety and environmental issues	Is able to suggest modifications to procedures to minimize environmental damage

CRITERIA FOR ASSESSING SCIENTIFIC PROBLEM-SOLVING SKILLS

C. ORGANIZING AND COMMUNICATING

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Organizes data in sets of concrete objects	Organizes data in sets of objects	Organizes data in the form of sets, themes, and/or tables	Organizes data accurately
	- Provides a basis for the organization of data sets - Constructs simple graphs to represent the data	- Provides a basis for and suggests alternatives for the organization of data - Is able to construct graphs and/or tables to represent the data	Is able to represent data using appropriate graphs and tables
	Performs basic mathematical calculations	Performs basic mathematical calculations	Performs relevant and required mathematical calculations
	Identifies, with teacher assistance, errors and inaccuracies	- Identifies errors and discrepancies in data - Takes part in teacher-directed discussion of scientific inaccuracies	Expresses measured and calculated quantities to precision

CRITERIA FOR ASSESSING SCIENTIFIC PROBLEM-SOLVING SKILLS

D. ANALYSING

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Correctly identifies patterns within the data	Assesses patterns and trends that are conceptually presented by the data	Assesses patterns, trends, and simple relationships	Assesses patterns, trends, and relationships resulting from collected and manipulated data
Identifies, with teacher assistance, relationships	Identifies simple cause and effect relationships	Identifies cause and effect relationships	Identifies the sources of error in data collection and manipulation
	Identifies, with teacher assistance, the sources of error in data collection and manipulation	Identifies the sources of error in data collection and manipulation	Expresses accuracy qualitatively and/or quantitatively (percent difference), where applicable
	Identifies, with teacher assistance, the effect of errors on results	Suggests amendments to procedures and/or data manipulation in order to rectify results	Identifies the assumptions relating to measurement and/or analysis
			Determines the reliability of the data

CRITERIA FOR ASSESSING SCIENTIFIC PROBLEM-SOLVING SKILLS

E. CONNECTING, SYNTHESIZING, AND INTEGRATING

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Provides a simple but not necessarily appropriate answer to the problem investigated based on results obtained	Provides a simple answer that is appropriate for the problem investigated and results obtained	Provides an appropriate answer to the problem investigated based on results obtained	Provides a qualified answer to the problem investigated
	Attempts to relate results to knowledge that is not specifically related to scientific theories or laws	Relates results, with teacher assistance, to applicable theories and/or laws	Relates the data to laws, principles, models, or theories identified in background information and/or in broader context
			- Proposes and explains interpretations or conclusions - Develops theoretical explanations

CRITERIA FOR ASSESSING SCIENTIFIC PROBLEM-SOLVING SKILLS

F. EVALUATING THE PROCESS OR OUTCOMES

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
Attempts to explain results to the problem investigated	Attempts to explain results to the problem investigated	Is able to explain the results obtained in light of the problem being investigated	Evaluates the prediction and concepts	Restricts, revises, or replaces an unacceptable scientific concept
	Attempts to draw conclusions where applicable and when prompted	Draws conclusions and attempts to explain them	Draws conclusions and attempts to explain them	Establishes criteria to judge the design, prediction, and concepts
		Discusses the limitations of the data collected, interpretations, and/or conclusions	Identifies limitations of the data and information, interpretations, or conclusions, as a result of the design of the experiment, research, or project	Considers consequences and perspectives
		- Discusses, when prompted, the validity of results - Discusses, when prompted, alternatives and/or improvements to the experimental design	Suggests alternatives and considers improvements to experimental technique and design	- Evaluates assumptions and effects of bias - Evaluates the total investigation in terms of reliability and validity

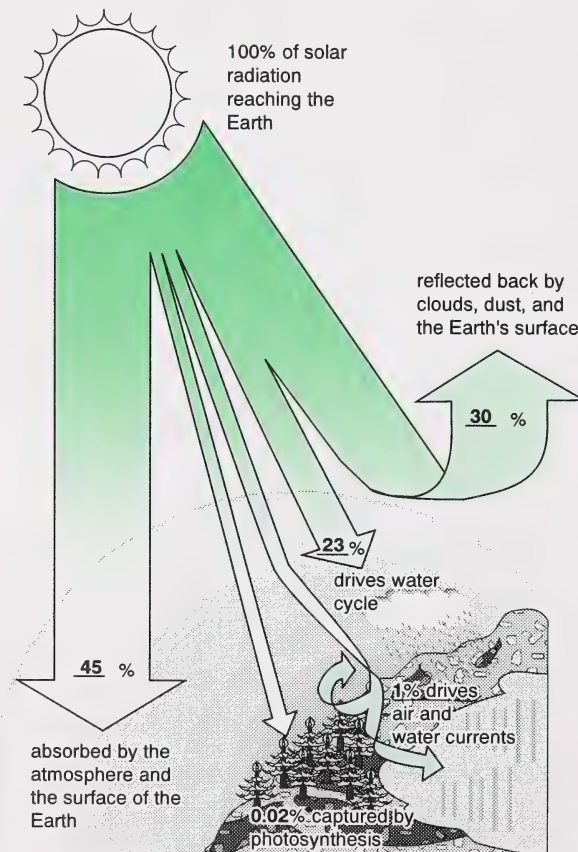
Suggested Answers

Section 1: Activity 1

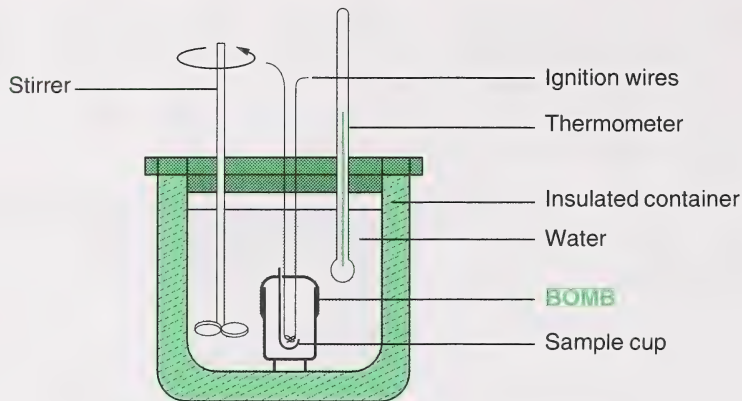
1. The young people are practising skill B – collecting and recording. They probably also practised skill A – initiating and planning – before going on their field trip to the pond.
2. The students in the laboratory are organizing and communicating – skill C.
3. The scientist may be connecting, synthesizing, and integrating data – skill E. He may also be performing skill F – evaluating progress.

Section 1: Activity 2

1. This is a sample model:



2. In summer, Alberta receives the greatest amount of solar radiation because the northern hemisphere is tilted toward the sun. In winter, Alberta receives the least solar radiation because the northern hemisphere is tilted away from the sun. Alberta receives the same amount of solar radiation in the spring and fall because the northern hemisphere is in the same position in relation to the sun.
3.
 - a. Clouds will increase the earth's albedo (the reflectivity of a material) and reflect more solar radiation. This will cause a reduction in air temperature below the cloud cover.
 - b. Ground temperatures will be lower.
4. Snow and ice have a high albedo. Therefore, radiant energy will be reflected more and lower temperatures will be produced. Less energy will be retained.
5. The battery farmer provides artificial sunlight, heat, and food "direct to the doorstep" of the chickens.
6. These chickens live naturally. They receive sunlight directly, produce their own heat, and search out their own food.
7. You are probably thinking that these eggs should not be more expensive. The farmer does not do anything to help the chickens. However, the free range chickens must use more energy to live, so they will produce fewer eggs. This will make more sense as you continue to watch the video.
8. Photosynthesis is the transformation process whereby solar energy is trapped in the chemical bonds in carbohydrates.
9. A food chain is an example of the flow of energy through living organisms. Producers capture solar energy. Producers are eaten by herbivores and herbivores are eaten by carnivores. Decomposers recycle the matter.
10. You can measure the warming effect with a calorimeter. This instrument was introduced to you in Science 10.
11. One method of measuring solar radiation is through the use of a solar cell connected to a voltmeter as shown in the video. A pyranometer and pyradiometer are used by Environment Canada to measure solar radiation in Megajoules per square meter.
12. A bomb calorimeter is an instrument that measures the heat produced when a substance is completely burned. The diagram that follows shows that the heat transfers to the water. The temperature increase, volume of water, and specific heat of water can be used to calculate the exact heat transfer. The addition of oxygen to the bomb allows for a complete combustion of the substance.



13. Your completed chart should look like this:

Sample	Energy Input	Energy Stored	Efficiency
Whole Plant	100 Joules/m ²	<u>2</u> Joules/m ²	<u>2</u> %
Leaf	100 Joules/m ²	<u>20</u> Joules/m ²	<u>20</u> %

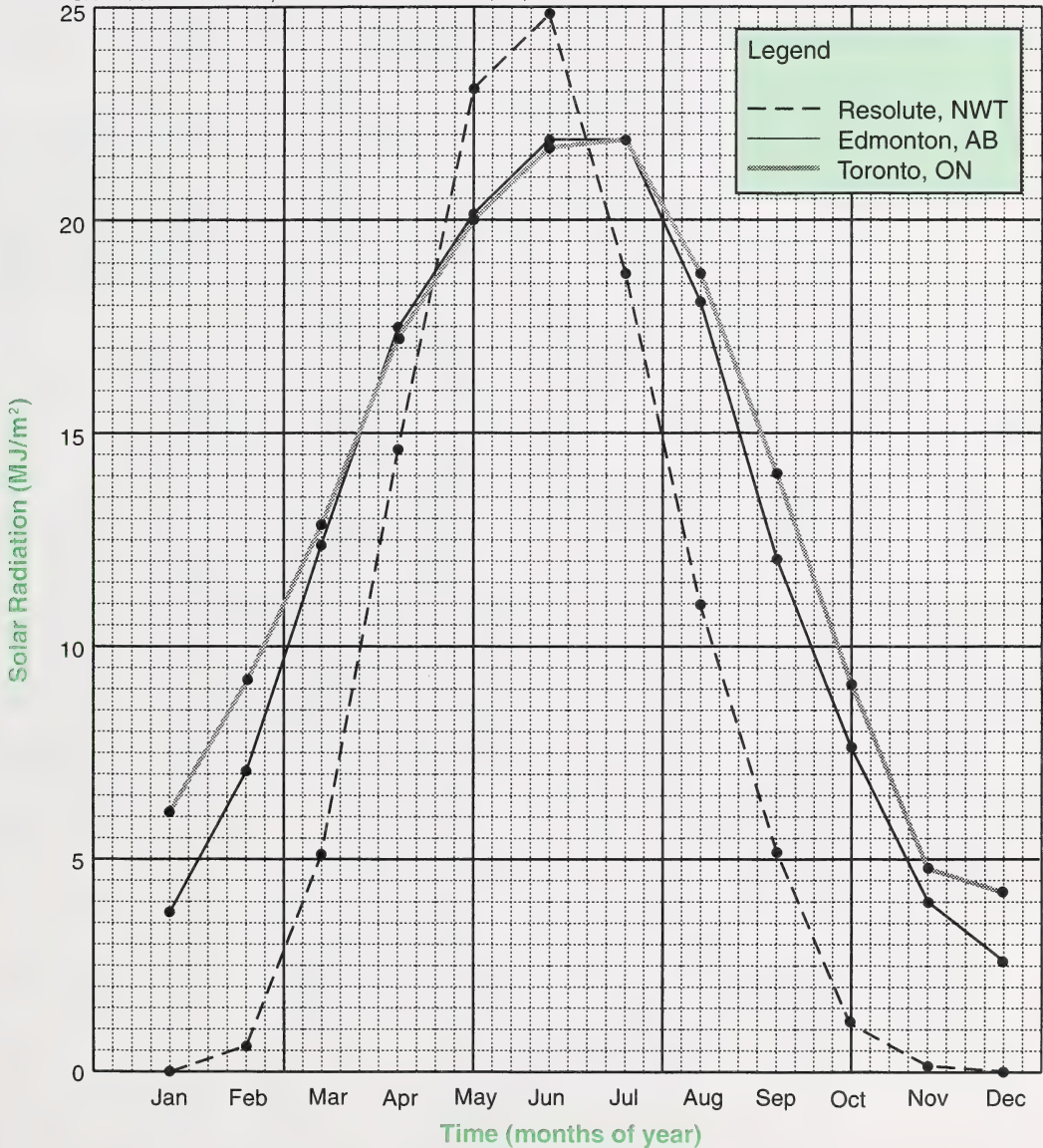
14. The other parts of the plant do not store energy as efficiently as the leaves. The whole plant includes stems and branches. This reduces the overall efficiency of the plant.
15. Weighing the insects gives an initial measurement. The calorimeter can then be used to determine the amount of energy per gram of biomass.
16. Your completed chart should look like this:

Example	Food Energy Input	Biomass Produced	Efficiency
Caterpillar	10 g (leaf)	<u>1</u> g	<u>10</u> %
Battery Farm Chickens	20 g (feed)	<u>10</u> g (egg)	<u>50</u> %
Free Range Chickens	100 g (feed)	<u>10</u> g (egg)	<u>10</u> %
Cat	50 g (meat)	<u>1</u> g	<u>2</u> %

17. As shown in the chart, the battery farm chickens produce eggs more efficiently. This means more eggs for the same cost, so these eggs are less expensive.

18. The energy in biomass is transferred from organism to organism along a food chain. Eventually, the energy is lost as heat into the atmosphere. It is then lost into space.

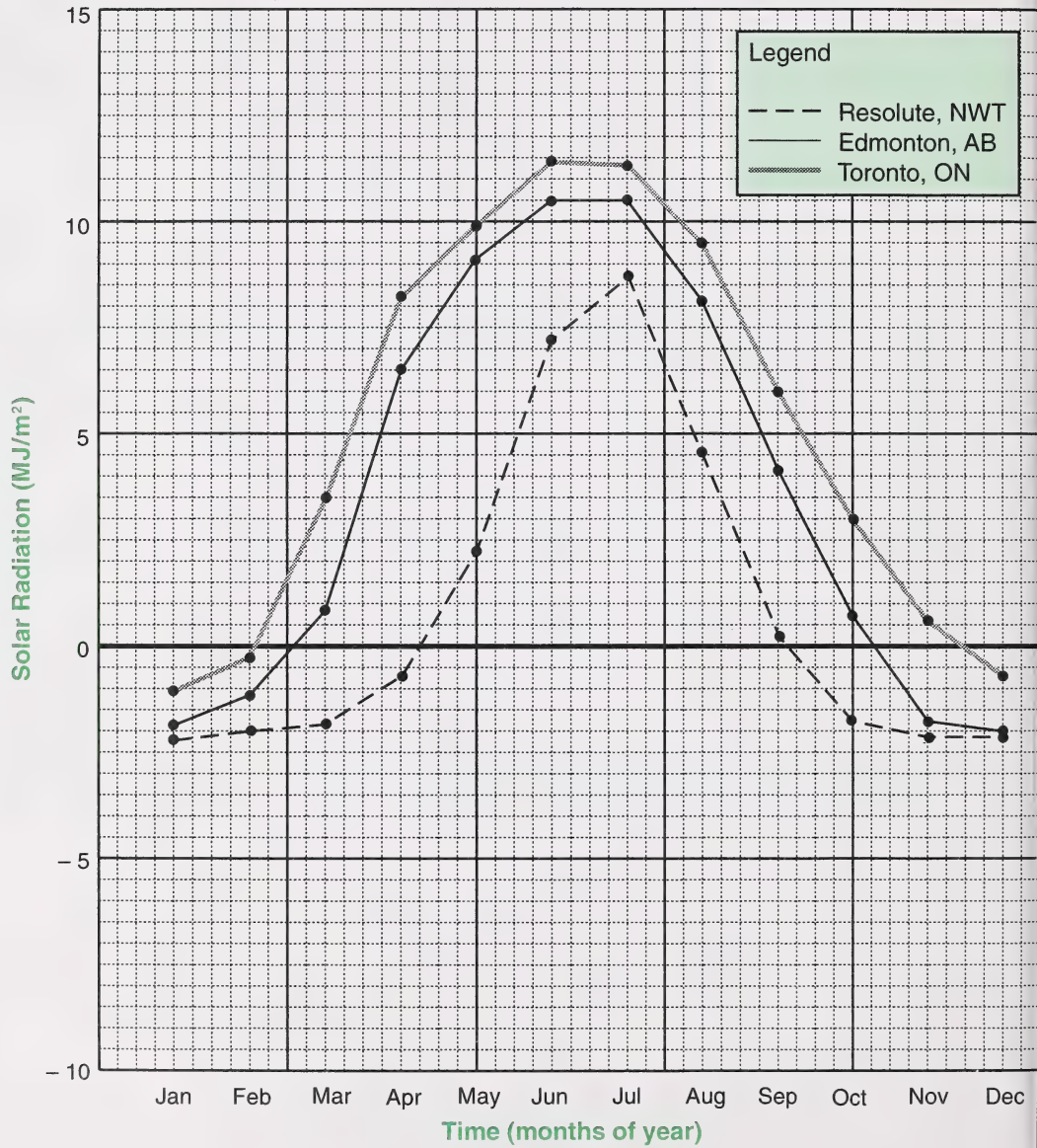
GRAPH 1.1: Mean Daily Global Solar Radiation (RF1)



19. The revolution of the earth around the sun changes the number of daylight hours during the year. Obviously, there is no daylight in the winter in Resolute, NWT.

20. Toronto is closer to the equator than Edmonton and Resolute, so there will be more daylight hours per year. Therefore, it will have a flatter data line.
21. All three locations will receive the same amount of solar radiation in late April and in late June because of the position of the sun and the tilt of the Earth on its axis.

GRAPH 1.2: Mean Daily Net Radiation

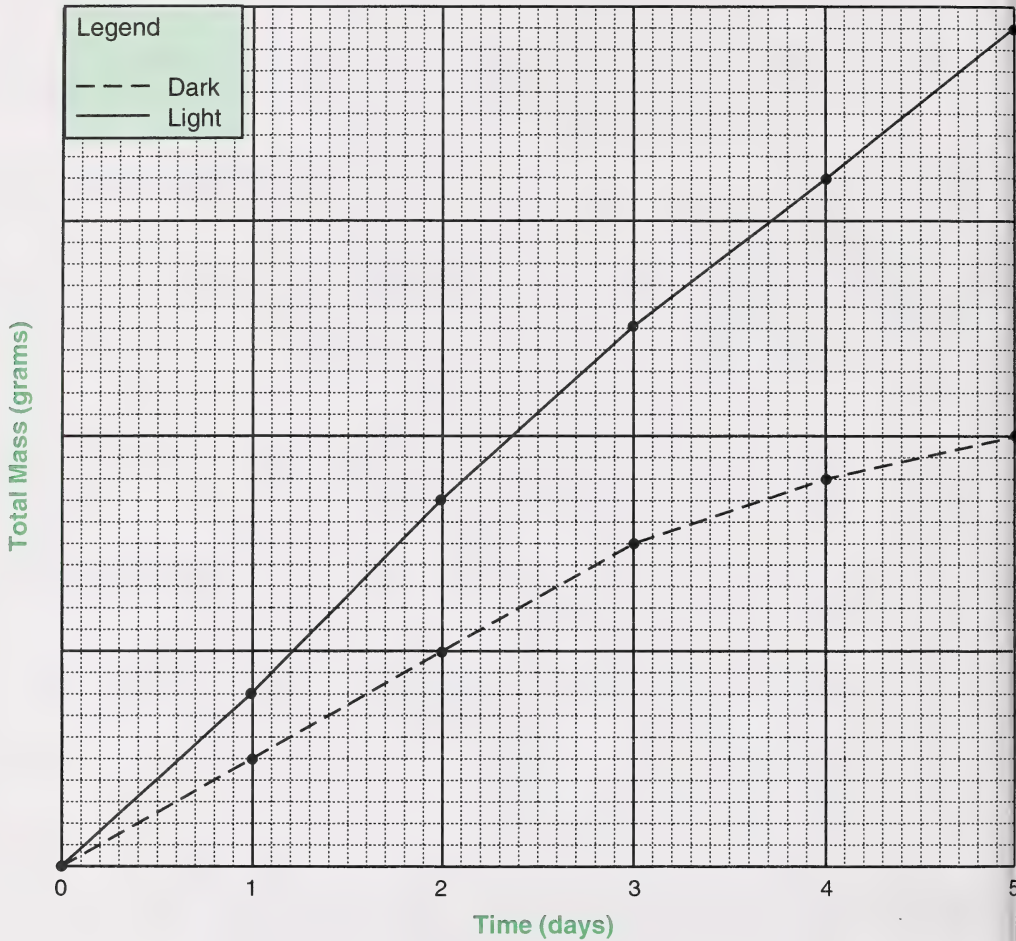


22. More energy is being lost from the earth than is being received from the sun. This net loss creates a cooling effect.
23. Edmonton has the same net radiation for June and July. From Graph 1.1, you will see that it receives the same solar radiation in those months as well. Edmonton must lose the same amount of energy in June and July.
24. The data lines do not cross at all. This will affect the number and kind of life forms that can live in each location.
25. Photosynthesis converts low-energy compounds (CO_2 and H_2O) into high-energy products (carbohydrates) by converting solar energy into chemical energy.
26. Cellular respiration releases energy from carbohydrates and produces CO_2 and H_2O .
27. Plants take in, transform, and release energy. Solar energy is the input. Photosynthesis is the transformation and the output is the carbohydrates. Most of the transformed energy is stored in carbohydrates, although some is lost as heat. Plants have a low heat signature compared to warm-blooded animals.
28. Energy is lost when organisms perform life processes. This energy cannot be reused. More energy must be obtained.
29. Your answer should include the concept of an energy balance and energy transformations. A technical definition is on page 52 in your text.
30. Your answer should include the concept of a continual energy loss as heat. A technical definition is on page 52 in your text.
31. If a maximum entropy existed on the Earth, then **all** life would cease to exist. This would occur if there was not a constant input of solar energy. Think of entropy as nonuseful heat energy. Which do plants use most, heat or light? Hopefully you said light. Some heat is needed to maintain water in a liquid state but light is needed for photosynthesis: Life on Earth depends on photosynthesis which depends on solar energy – primarily light energy.

Section 1: Activity 3

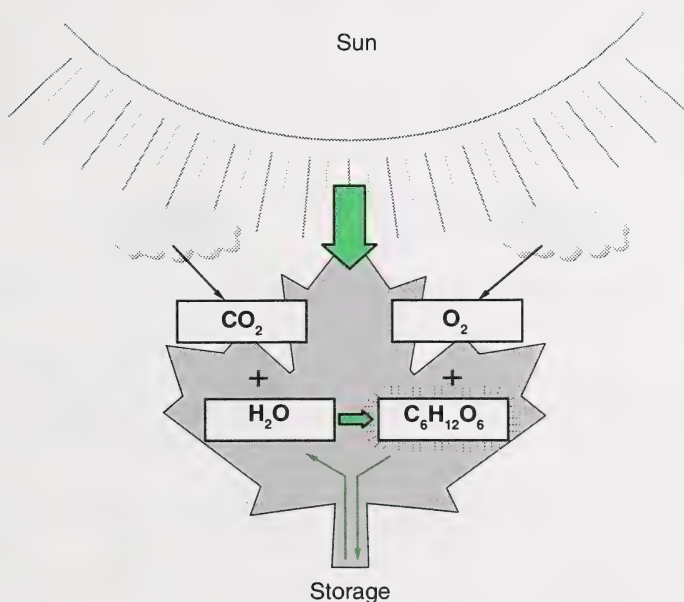
1. There are many life activities shown in this picture. You might notice the marmot and the young girl, but don't forget the plants, lichens, mosses. And, what about bacteria?

2. Sample Graphs for 1.3, 1.4, 1.5, Solar Energy Storage



3. The seedlings that grew in the light weighed more after five days than the seedlings that grew in the dark. These plants were able to photosynthesize and store solar energy as carbohydrates. This would account for a greater increase in weight. The graphs all show that the mass of seedlings grown in light increases faster than the seedlings grown in dark.
4. By using ten seedlings individual differences are less important. Weighing all ten could then allow you to average the weight for each type to compare them.
5. The seedlings growing in the dark use some of the stored energy and absorb water. Eventually they will decrease in weight because they are using up the energy stores; then they will die.

6. Cooling the plants will slow down the process of photosynthesis. The seedlings will grow more slowly, so the mass will not increase as fast.
7. Plants must slow down their energy use during the winter because they are storing less solar energy. Obviously many plants die because their energy output does not slow down enough. Also their energy input is extremely low because they have no leaves.
8. Your completed flow chart should look like this:



Section 1: Activity 4

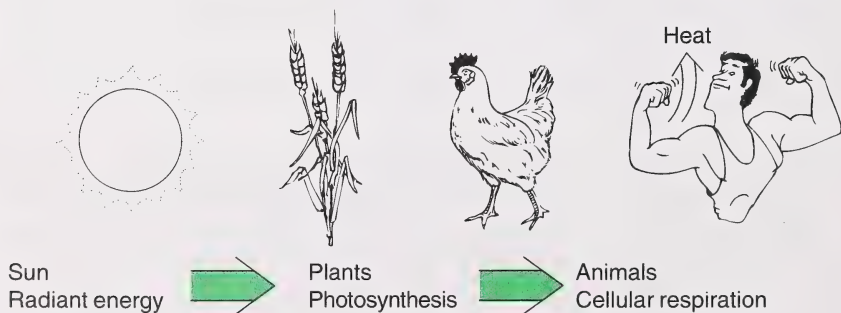
1. By setting up a control apparatus without any seeds, you will be able to find out if there are any temperature changes that are not caused by the seeds.
2. The use of dry seeds will give you data about living organisms at rest. You may expect very little temperature change if any.
3. There should be no temperature change in the control. A small temperature change in the dry seeds would indicate that very little energy is needed to remain dormant. A large temperature change in the germinating seeds will show that metabolic processes have once again begun and some of the energy is being lost as heat.
4. This investigation should work very well and your actual results should confirm your prediction.

5. If seeds are wet when they are stored, then there is a good chance they will germinate and grow. Unless they are planted they will die. They will also probably rot. There will be a heat loss because the seeds begin to germinate. They will now contain less energy for later use.
6. The temperature rise is a result of heat loss during metabolic activity. Apparently there was not enough energy used in growth to produce a pea plant from the seed.

Section 1: Follow-up Activities

Extra Help

1. The rapids in the river create a really rough ride. The energy of the moving water is transferred to the raft and then to your body.
2. You must hold on to something solid, like the raft. This requires muscle contractions which use up stored energy.
3. Your stored energy comes from the food you eat. It is digested and transported to your muscles for use.
4. No, the animal products contain less energy per gram than the grain. As energy is transferred from plants to animals, some is lost. The plant uses energy to grow and some is lost as heat. Therefore, animals receive less energy per gram from the plants.
5. During photosynthesis plants produce energy-rich carbohydrates and store them as starch. Oats are actually seeds. A seed is an embryo plus an energy supply.
6. It comes from the sun. The solar energy will also warm the air and water which makes whitewater rafting more enjoyable.
7. Your flow chart should include the following items:

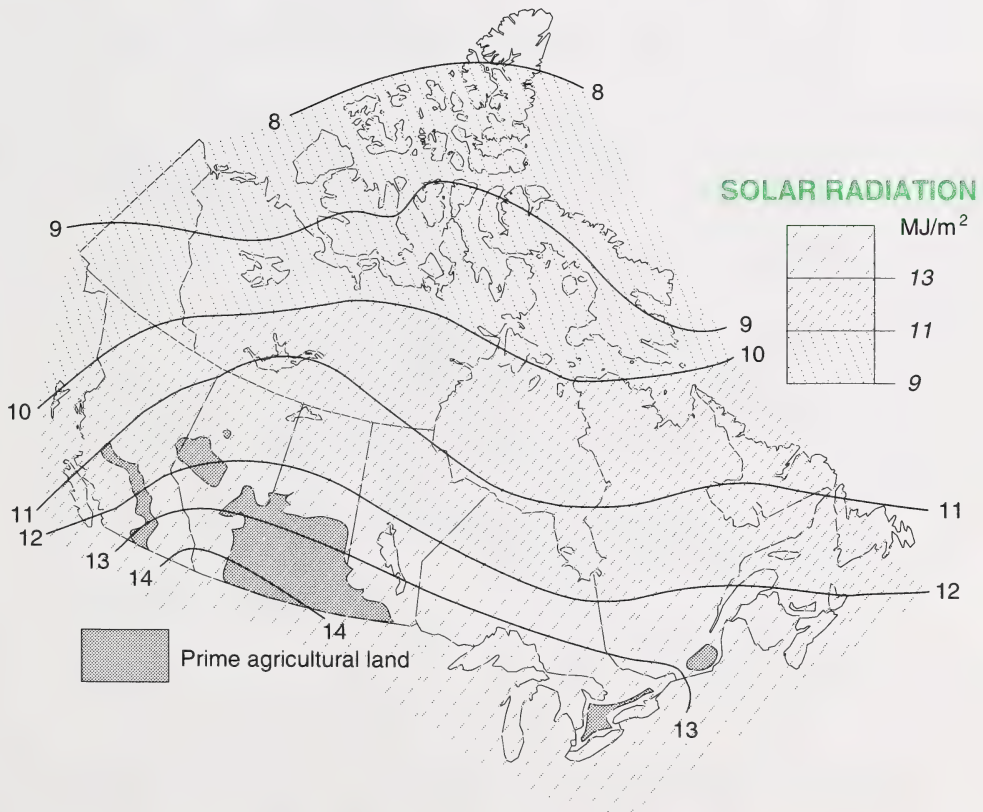


Enrichment

1. Contact the Production Economics Branch of Agriculture Alberta. Information on the costs associated with grain, dairy, poultry, and livestock production can be obtained.

Write to
 Production Economics Branch
 Alberta Agriculture
 3rd Floor, 7000-113 St.
 Edmonton, AB
 T6H 5T6
 (403) 427-4005

2. Use encyclopedia and atlases to create a map that is similar to the one that follows.

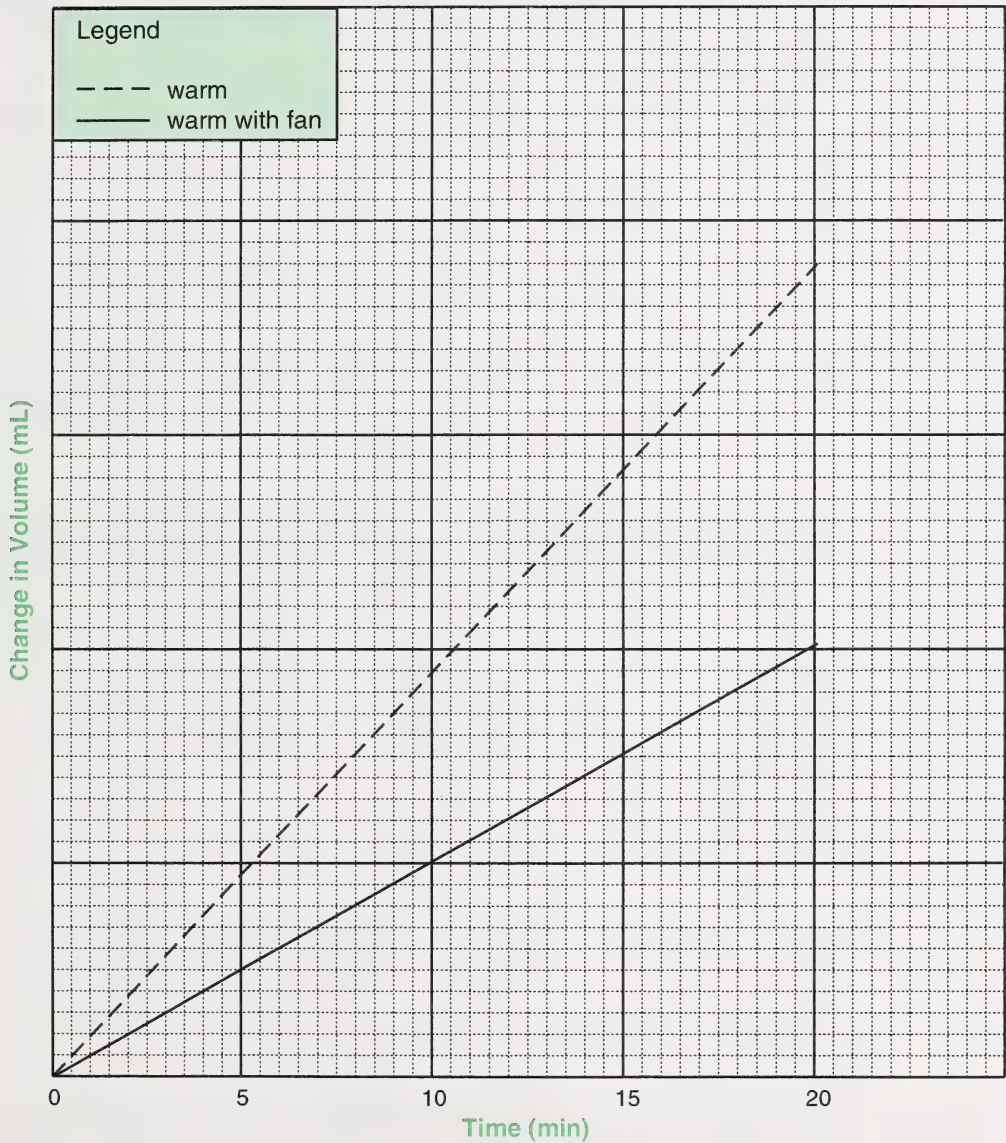


3. Substituting more grains, vegetables, and fruits will provide you with more energy per unit of biomass. As energy is transferred through the biosphere, as in a food chain, there is a significant energy loss at each point of exchange. Consult the Canada Food Guide for more information.
4. Basically, your system must capture metabolic heat lost and move it to warm another area. The cool air intake must be where the metabolic heat is produced. For more detailed information consult Canada Square Management in Calgary (237-8430).

Section 2: Activity 1

1. Water absorbs and releases heat energy. It has quite a high specific heat which serves to keep its temperatures relatively stable. To change from solid to liquid or liquid to gas requires large amounts of energy. This helps stabilize global temperatures especially since 70% of the earth's surface is liquid water.
2. The abiotic processes are evaporation and precipitation. The biotic processes are transpiration, which is evaporation from plants, and cellular respiration in plants and animals.
3. The combustion of fossil fuels releases sulphur dioxide (SO_2) and various oxides of nitrogen (NO_x) into the atmosphere. They combine with water droplets to form dangerous acids which return to the earth in snow and rain.
4. Acid rain can damage an ecosystem by
 - changing the pH in soil and water
 - killing fish, soil bacteria, and plants
 - increasing weathering and erosion of rock
 - rusting metal
5. Some of the solutions you might choose are
 - alkaline soil neutralizes the acid
 - building taller smokestacks
 - scrubbers on smokestacks
 - using alternative fuels
 - adding lime to lakes
 - reducing exhaust emissions

6. Sample Graph 1.6, Water Loss in Plants



7. The warm environment will promote evaporation through the leaves to cool the plant.
8. When the fan is added in this investigation, the amount of evaporation increased. Air speed will alter the amount of water vapour escaping from the leaves. This is part of the reason that crops dry out quickly in very windy parts of Alberta.

9. You may choose to increase the temperature and wind speed to elevate water loss.

- Place a plastic bag over the plant to increase relative humidity. When there is already a large amount of water vapour in the atmosphere, there is less evaporation.
- Use a different plant with more leaves so the surface area for evaporation is increased.

Section 2: Activity 2

1. The complimentary biotic processes are photosynthesis and respiration. Photosynthesis removes CO_2 from the atmosphere and cellular respiration adds CO_2 to the air.
2. Fossil fuels such as coal, petroleum, and natural gas contain the chemical energy stored for long periods of time in carbon compounds. When burned the energy is released and can be used to perform work. Water and carbon dioxide are still the waste products which are returned to the air just as in respiration.

3.

Processes that increase CO_2	Processes that decrease CO_2
aerobic respiration	photosynthesis
decomposition	dissolving in oceans
weathering	
combustion	
volcanic eruption	

4. Gases within the atmosphere, such as CO_2 and CFCs, act like the glass of a greenhouse. They trap long-wave radiation (heat) that is produced by the Earth when short-wave radiation (visible light) is received from the sun. This blanket of heat warms the Earth well above what the average temperature would be without an atmosphere. It also carries the heat above the Earth's surface.
5. The result would be a global warming that may continue to melt the polar icecaps. The ocean levels would rise and flood coastal areas. More deserts would be produced and agriculture would be disrupted worldwide.

6. As global warming occurs, there will be more evaporation. This will affect weather patterns that may lead to extreme dryness in some areas and tremendous rain in others. The hydrologic cycle would continue to move water through the biosphere, but at different rates in different places.

7. Total O₂ produced in 24 hours by all plants

$$= 10 \text{ mL/hour/g} \times 20 \text{ hours} \times 1\,000\,000 \text{ g}$$

$$= 200\,000\,000 \text{ mL/day}$$

Since the O₂ produced equals CO₂ consumed by the plants, the production of CO₂ by plants and animals must equal 200 000 000 mL.

8. Total CO₂ produced by the plants per day

$$= 5 \text{ mL/hour/g} \times 4 \text{ hours/day} \times 1\,000\,000 \text{ g}$$

$$= 20\,000\,000 \text{ mL/day}$$

9. Total CO₂ produced by the astronauts per day

$$= 200\,000\,000 \text{ mL} - 20\,000\,000 \text{ mL}$$

$$= 180\,000\,000 \text{ mL/day}$$

Mass of the astronauts

$$= \frac{180\,000\,000 \text{ mL/day}}{5 \text{ mL/hour/g} \times 24 \text{ hour}}$$

$$= 1\,500\,000 \text{ g}$$

At an average of 75 kg/astronaut there could be 20 astronauts permanently in this space station.

10. There are many experiments you could have designed. However, you may have decided to follow this format:

- Determine the mass of a leafy, aquatic plant such as elodea and the mass of a goldfish. Record the mass in a chart.
- Put the plant in the respirometer as shown in Figure 1.5.

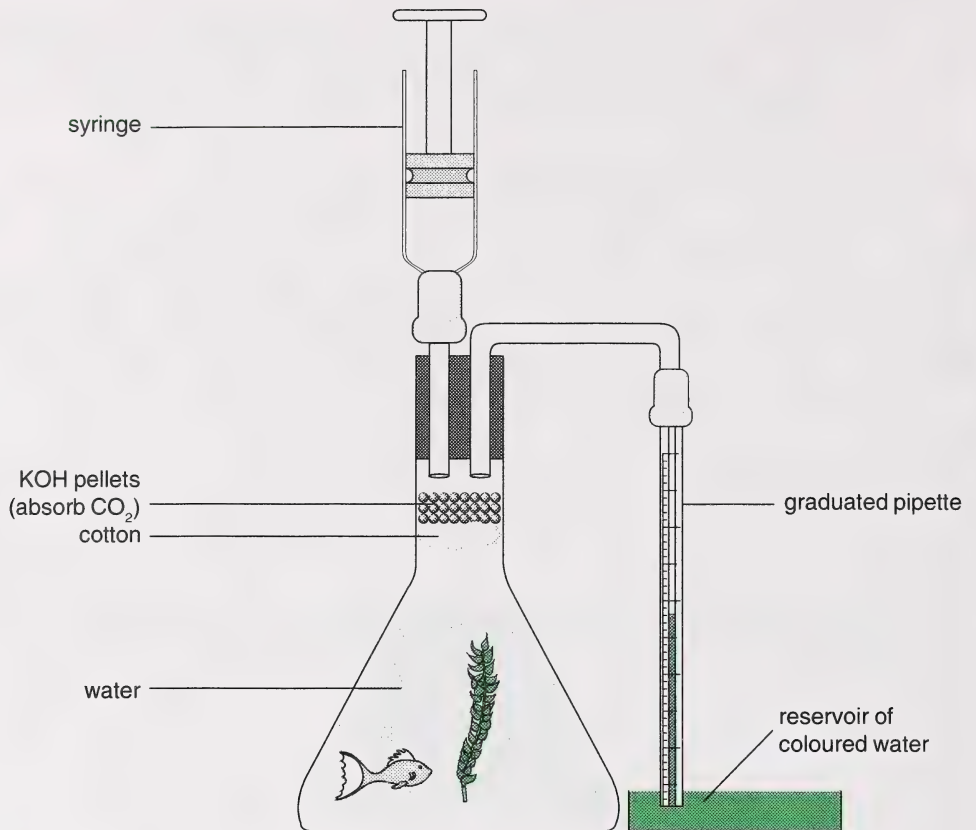


FIGURE 1.5 Respirometer

- Allow the apparatus to stay in the light for 4 hours. Record the level of coloured liquid each hour.
- Move the apparatus to a dark place and repeat the previous step.
- Remove the plant and water from the apparatus. Place aerated water and the goldfish in the flask and repeat the previous step.

This design will help you determine the CO_2 production in the plant and animal. The rest is mathematics.

Section 2: Activity 3

1. Nitrates are produced when nitrogen and oxygen are bonded together chemically (NO_3).

2. Nitrogen fixation occurs abiotically when lightning causes N_2 to react with O_2 and produce NO_3^- . Thunderstorms can produce rain with nitrates in the drops. Nitrogen-fixing bacteria grow on the roots of legumes such as clover and alfalfa. This biotic process also creates nitrates.
3. These bacteria break down nitrates in the soil so the grass cannot produce proteins like chlorophyll that make your grass green. This is why the lawn does not have a rich green colour if it is short of nitrates.
4. The legumes allow nitrogen-fixing bacteria to produce nitrates. There are usually more produced than are required. The excess serves as a fertilizer in the soil for other plants. If the rows are moved to new locations in your garden each year, you can continue the natural fertilizing process.
5. Phosphates are produced when phosphorus and oxygen are bonded chemically (PO_4).
6. The long-term cycle is abiotic and involves the movement of soluble phosphates from land to oceans to sediments and back to the surface. This could take millions of years. The short-term cycle is biotic and involves the transfer of phosphates between plants and animals through feeding, decomposition, and absorption of water by plants.
7. Soil fertilizers have been used to restore the depletions created by continually planting and harvesting crops. These additions to the soil can maintain a balance and allow repeated harvests.
8. An excess of fertilizer in water systems is a major concern in Alberta because it promotes increased plant growth. This causes problems with irrigation systems. The same result occurs when excess detergents are added to the waterways. Phosphates and nitrates increase plant growth. When the plants die the decomposing plant material causes an oxygen depletion which leads to the death of fish. This only adds to the decomposition process and more oxygen depletion.
9. The most obvious solution is to be careful in using fertilizers and detergents. Many cities could add nitrate and phosphate removal systems to their sewage treatment process or waterways. You could use phosphate-free detergents in your home and look for more natural ways to fertilize your lawn such as mulching the grass clippings.
10. Reducing waste will minimize the use of landfills where many elements are stored for a long time before they enter the cycle again. Reusing allows humans to get the maximum efficiency from a product and keeps the cycle going. Recycling ensures that the biogeochemical cycles will proceed at as natural rate as possible. Recovering will help make waste management efficient.

11. This symbol can be found in many locations such as on

- paper products (newspapers, envelopes, books)
- aluminum cans and plastic bottles
- milk cartons and juice containers
- recycling centres and boxes

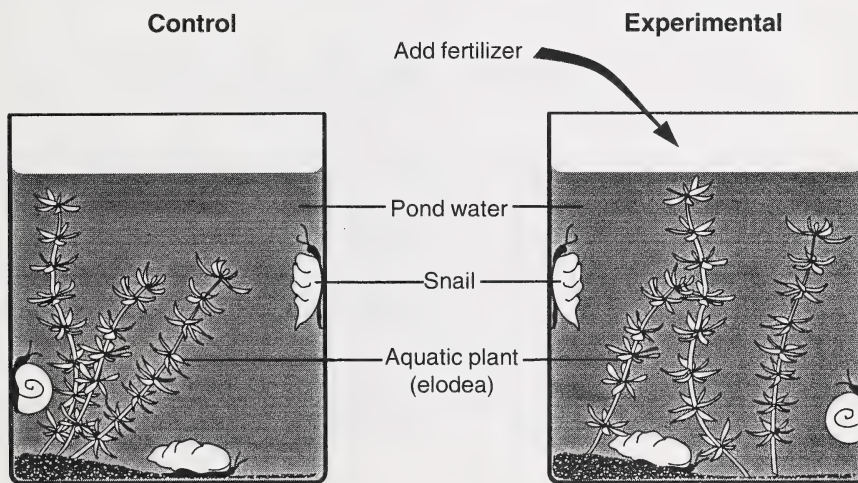
Section 2: Follow-up Activities

Extra Help

1. Liquid water **evaporates**, cools in the air, and forms **precipitation** which falls to the Earth.
2. Ice floats because it is less dense than water. The hydrogen bonding creates a larger crystalline lattice when the water freezes. Lakes and rivers will freeze from the top down, so fish can survive under the ice.
3. No life forms can survive without water so it must be preserved and protected for the future.
4.
$$6 \text{CO}_2 + 6 \text{H}_2\text{O} \xrightarrow[\text{energy}]{\text{solar}} \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2$$
5. Carbon dioxide is found in the air. It may come from respiration or combustion.
6.
$$\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O} + \text{heat}$$
7. Carbon dioxide moves into the air. It could be used for photosynthesis, dissolve in water, or simply stay in the air and trap energy (heat).
8. The greenhouse gas (CO_2) will build up and retain more heat in the atmosphere. This will lead to global warming.
9. These bacteria convert animal and plant protein into ammonia (NH_3) and nitrates (NO_3) that can be used by plants. These processes are important to the basic nitrogen cycle.
10. Phosphates are important in the structure of cell membranes, the energy storage molecule ATP, and the calcium compounds in bone. They are also found in the nucleic acids, DNA and RNA, which are heredity material.
11. The use of fertilizers in agriculture has served to maintain the cycles after harvesting. The heavy use of detergents has altered the phosphorus cycle resulting in overgrowths of plants. This pollution is a problem yet to be fully resolved.

Enrichment

- Here are some of the questions you could ask on your visit:
 - What is the quantity and composition of waste in your community?
 - How is your present system organized?
 - What is the local budget for solid waste management?
 - How much of the waste is placed in landfills?
 - What technology is used to prevent pollution from the landfill?
 - What is the life expectancy of your landfill?
 - Does your community have an incinerator?
 - What technology does the incinerator use to recover energy?
 - What type of recycling program exists in your community?
 - How much is saved by recycling and avoiding the landfill?
- A simple investigation may be undertaken using pond water and elodea and snails. Set up the apparatus as shown.



Add 1 g of fertilizer and observe each day for two weeks. Other experimental setups could examine the effect of different fertilizers.

- There is a "mini" water cycle for all organisms. You take in water when you drink, eat, and soak in the bath. You lose water in your breath, urine, feces, and sweat. Perhaps more important in the biosphere is how much water you use in daily activities such as watering your lawn, washing your food or clothes, showering, brushing your teeth, and flushing the toilet. Contact Alberta Environment and ask for the poster "The Living Flow: Water in Alberta" to be sent to you. Mention that you are studying biology. Then you will have a better idea of the human impact on the water cycle in Alberta. If you receive the poster, write a brief thank-you letter.

4. Burning fossil fuels for energy creates an imbalance in the carbon-oxygen cycle. The impacts include
 - air pollution
 - increased greenhouse effect
 - ozone depletion
 - water pollution

A visit to an oil refinery would help you get the most up-to-date information about what is being done to reduce the problems.

5. The distribution of precipitation during the year is a major concern to the farmer, builder, resort operator, and student. So many human activities are based on weather. Of course, plants must have water to grow. Relative humidity affects evaporation significantly. The result of water distribution will be explored further in Module 2.
6. Using raw materials, humans make products that can be used. Once the product has been utilized, then the disposal of waste occurs. Therefore, the garbage-producing process involves make – use – dispose .
7. Humans consume excessively large amounts of raw materials and energy. This leads to tremendous pollution and garbage production. There is no recycling in this process.
8. The burning of the waste reduces its volume by up to 90% before the ashes are taken to a landfill. The heat produced is used to generate electricity – enough to provide one third of the community's needs.
9. The aluminum cans are compressed and shredded first. Then they are melted and formed into ingots. The ingots are squeezed into sheets, rolled into coils, and then the manufacture of recycled cans occurs.
10. The cost will include the purchase of more landfills, higher taxes, higher garbage collection fees, more equipment and staff, greater contamination, and fewer raw materials available for use.
11. Refillable bottles are excellent examples of reuse. Also, reusing plastic or paper shopping bags will reduce garbage.

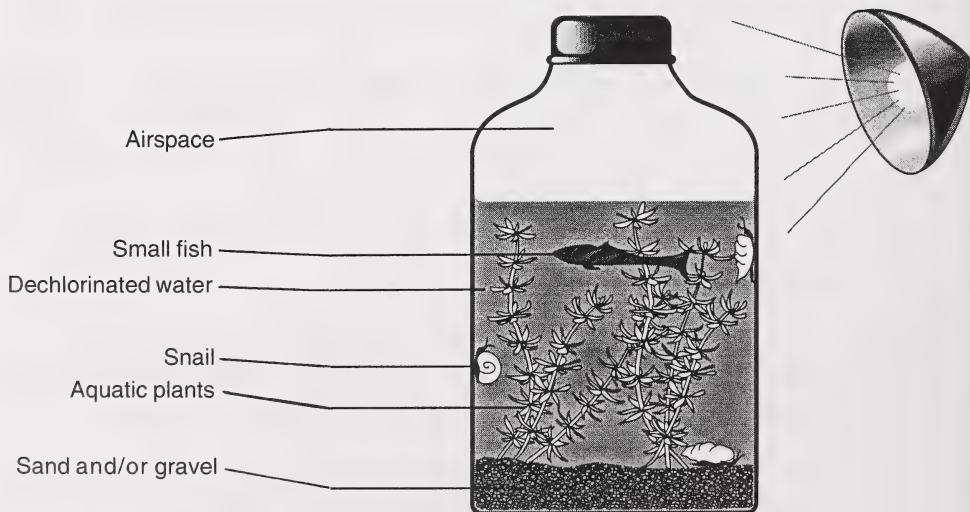
12. Some practical examples are listed in the following chart. There are many more things you could do.

Process	At Home	At School
Reduce	• turn down thermostat and water heater • use bulk packaging	• write on both sides of paper • turn off lights when leaving a room empty
Reuse	• keep leftovers for next meal • mend clothes • reuse shopping bags	• use binders from year to year • use ceramic dishes in cafeteria • repair chairs and desks
Recycle	• sort paper • sort cans • sort plastic • compost organic waste	• sort paper • sort cans • sort plastic • motor oil from auto class
Recover	• make quilts from old clothes • use bleach bottles to store water • use newspaper in pet cages	• use film canisters for art projects • make lost and found items available for use

Section 3: Activity 1

1. The Laws of Thermodynamics help to explain that the energy from the sun flows through the biosphere and is lost as heat: input equals output. Photosynthesis transforms energy and respiration releases it. Decomposition completes the process.
2. Yes and no! In a natural environment the elements are recycled over time, but human activities can make the environment unnatural. Pollution and man-made products can disrupt the balance.

3. A closed system is where there is no outside source of new raw materials, matter must be recycled inside. However, there is a constant source of new energy in a closed system. The biosphere is such as system.
4. Lovelock's metaphor is right on target. Like the constancy in your body, even though it deals with many changes every hour, the earth enjoys a similar constancy on a much larger scale. While your dynamic equilibrium continues, you enjoy life. When there is an imbalance, you are sick. So it is with the Earth.
5. Humans have begun to affect the constancy of the biosphere.
6. The following procedure could be used:
 - Put the sand or gravel in the jar (2-3 cm).
 - Fill the jar with dechlorinated water leaving about 2-3 cm for an airspace. Let tap water sit for about 48 hours to allow the chlorine to leave.
 - Add the aquatic plants. Cabomba (fanwort), ceratophyllum (hornwort), or elodea can be used.
 - Add the pond snails and fish. One or two small guppies can be used or a khuli loach.
 - Put the lid on the jar and seal it tightly.
 - Put the light source about 60 cm from the jar. Ensure that the apparatus is set up in a constant location where light and temperature do not change during the day.



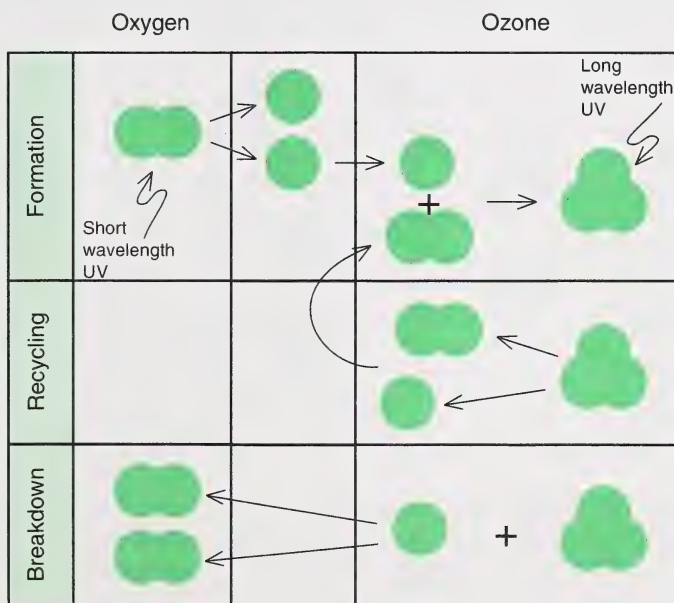
- Observe daily for a month.

7. The airspace acts as a gas reservoir, so there is an atmosphere is your system.
8. The green colour will become more intense because there will be an increased growth of algae.
9. The plants produce oxygen and carbohydrates for the animals. The animals produce CO_2 and H_2O for the plants. The snails and bacteria decompose waste for the plants to use in growth. A constant supply of energy and cycling of matter maintains a balance.
10. Turn off the light! If the plants cannot photosynthesize, soon the system fails. Adding chemicals to pollute the water could kill the animals, thus removing a raw material source for the plants. There are many other things you could do to disrupt of balance.

Section 3: Activity 2

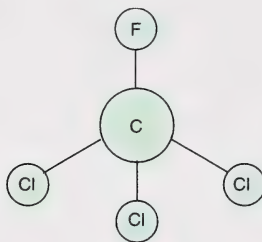
1. Ozone (O_3) is a bluish gas found in the stratosphere. It is the product of a chemical reaction between oxygen (O_2) molecules that absorb ultraviolet light. Formation and destruction of ozone normally balance each other as shown in the following diagram.

Natural Formation and Breakdown of Ozone in the Stratosphere



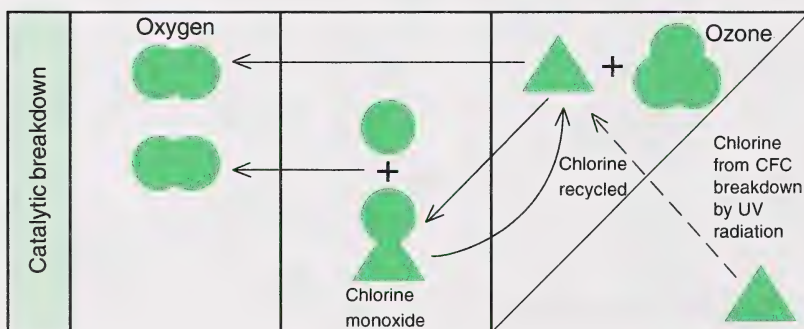
2. The ozone layer protects the earth from the damaging effects of ultraviolet radiation produced by the sun. The burning of skin and cellular mutations are two of the impacts on living organisms exposed to excess UV radiation.

3. The major cause appears to be the release of chlorfluorocarbons (CFCs) into the air. This pollutant is found in aerosols, coolants in air conditioners, refrigerators, and freezers, and a waste from the manufacturing of some foam plastics.
4. The discovery of chlorfluorocarbons (CFC) revolutionized refrigeration. This non-toxic, highly stable, compound could retain heat. There were so many uses that the problem of CFCs in the atmosphere never arose at first. The compound is made from a central carbon atom bonded to a fluorine atom and three chlorine atoms.



5. Ultraviolet radiation breaks the CFCs down releasing chlorine atoms. Each chlorine atom can breakdown 100 000 molecules of ozone. You can see that very little CFC can have a dramatic effect on the ozone layer. This process is illustrated in the following diagram:

Destruction of ozone by catalysts



6. Ozone is produced when ultraviolet radiation strikes the atmosphere. There is more direct light striking the Equator region, so there is more ozone produced there. The prevailing winds will continually move the ozone toward the poles.

7. An ozone depletion will increase the amount of UV radiation striking the earth. A subsequent increase in skin cancer, premature wrinkling, and damage to the retina and cornea of the eyes in humans will be observed. Legumes, including beans and peas, squashes, and lettuce are extremely sensitive to UV radiation. The breakdown of plant proteins could affect food chains around the biosphere.
8. The development of hydrofluorocarbons (HFC) may help solve the problem of ozone depletion. Substituting hydrogen atoms for chlorine atoms will save the atmosphere because HFCs will break down before reaching the stratosphere and there will be no toxic chlorine atoms released.
9. Humans must eliminate the use of CFCs and allow the production of ozone to occur naturally.

Section 3: Activity 3

The video provides the following answers:

Human activities that increase greenhouse gases	Human activities that decrease global warming
• burning fossil fuels to – produce electricity – run automobiles – remove forests • garbage disposal and decomposition • refrigeration and coolants • manufacturing styrofoam • using fertilizers in soil	• switch to renewable energy resources – solar energy – wind energy – electric cars • use energy more efficiently – government laws – building designs – recycling heat – better light bulbs – insulate attics – better mileage for cars • recycling programs at school • planting trees to remove CO₂ from atmosphere

Section 3: Follow-up Activities

Extra Help

1. The two processes are

Photosynthesis

Cellular Respiration

Photosynthesis takes CO_2 from the air and replaces it with O_2 . Cellular respiration takes O_2 from the air and adds CO_2 .

2. Each definition should be completed as follows.

- The most abundant greenhouse gas is CO_2 .
 - During photosynthesis O_2 gas is produced.
 - CFC is used to make plastic foams and refrigerator coolant.
 - A buildup of greenhouse gases causes global warming.
 - The most abundant gas in the atmosphere is N_2 .
 - CH_4 is a product of bacterial decay.
 - Heat is trapped in the atmosphere when H_2O forms around CO_2 .
 - The breakdown of CFC by ultraviolet radiation causes ozone depletion.
 - N_2O is a greenhouse gas produced from animal wastes as well as fertilizers.
 - Ozone protects the earth from ultraviolet radiation.
3. Most CFCs are produced by cooling devices like air conditioners, freezers, and refrigerators. Modern society is utilizing this technology more and more.
4. CFC production levelled off over that period primarily as a result of the restrictions placed on aerosol spray can use.
5. Industrialization greatly increased the burning of fossil fuels for energy. That search for energy continues today and burning pours tonnes of CO_2 into the atmosphere. Removing vast forests is another way to keep CO_2 levels high since photosynthesis cannot take place to remove the CO_2 from the atmosphere.

6. The amount of CO₂ has increased 25% since 1840 and the global mean temperature has increased continually as well. Since human activities have not slowed or reduced CO₂ production, it follows that global warming will not slow or decrease.
7. The information for this pie graph comes directly from Table 1.6 on page 135 of your text. The relative amounts of each greenhouse gas can be shown clearly with this type of chart.

Enrichment

1. The collage or scrapbook should cover the following activities that impact on the atmosphere:
 - producing “urban heat islands” that warm air
 - contamination by various air pollutants
 - creation and deposition of acid rain
 - depletion of the ozone layer through release of CFCs
 - increasing global warming through the burning of fossil fuels, extensive high-input agriculture, deforestation, and increased waste decomposition
2. On page 42 of your text there is an outline for such a debate. Research aids may be obtained from libraries and government agencies, including Environment Canada’s Atmospheric Environment Service.
3. Details of all Green Plan Initiatives that the government has begun are outlined in a 24-page report called “Canada’s Green Plan: The First Year.” Ask your Member of Parliament for a personal response to this issue when you request the report. Remember to write a short thank-you letter.
4. This is an excellent resource that explains the dynamics of the greenhouse effect, the greenhouse gases, ozone depletion, and effects of climate change. There are many recommendations for action that can be selected to help improve the quality of air in your area. Good luck with your project!

SKILL ASSESSMENT RECORD														
Feedback From Assignments			Initiating and Planning		Collecting and Recording		Organizing and Communicating		Analyzing		Synthesizing and Integrating		Evaluating	
Module	Section	Question	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher	Self	Teacher
1														
2														
3														
4														
5														
6														
7														

30

Section 1 Assignment: Flow of Energy

Review the Evaluation information found in the introductory pages of this module.

Read all parts of your assignment carefully. Record your answers on your own paper, making sure they are neat and organized, with wide margins and space for teacher comments. It is important to number and clearly identify each page with this information at the top.

Biology 20 – Module 1 Section 1 Assignment Page # Name and ID Number

1. If the daylight hours during the summer in Alberta were cut in half because of cloud cover resulting from vast forest fires, describe the effect on energy flow to living organisms starting with photosynthesis. **(1 mark)**
2. As energy flows through the biosphere, living organisms accumulate some of it in carbon compounds with a high energy content. How is this knowledge important to farmers? **(1 mark)**
3. Explain the difference between Global Solar Radiation and Net Radiation. **(2 marks)**
4. The data that follows was collected at the Solar Radiation Station in Suffield, AB.
 - a. Using your own graph paper, draw a two line graph (with legend) to show the relationship between the time of day and solar radiation received in January and July. Remember to give the graph a title. **(3 marks)**

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☒ F. Evaluating

Month \ Time of day	Solar Radiation (KJ/m ² /hour of the day ending)																							
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0	0	0	0	0	0	0	17	197	511	779	930	939	796	528	218	21	0	0	0	0	0	0	0
Jul	0	0	0	4	88	436	922	1450	1957	2384	2652	2749	2744	2589	2334	1911	1416	897	427	92	4	0	0	0

- b. What is the average hourly solar radiation in January and July? **(2 marks)**
- c. Explain the difference between these two averages. **(2 marks)**

The following data was obtained for July at the Solar Radiation Stations in Churchill, MB and Halifax, NS.

Station \ Time of day	July Solar Radiation (KJ/m ² /hour of the day ending)																							
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Churchill, MB	0	0	4	42	205	482	821	1198	1542	1856	2095	2183	2179	2040	1823	1525	1202	830	478	201	38	0	0	0
Halifax, NS	0	0	0	0	25	214	545	939	1341	1722	2024	2246	2283	2162	1898	1538	1089	662	268	33	0	0	0	0

- From all the data provided, why might Alberta be the best place for a wheat farm? (1 mark)
- Why is sunrise later and sunset earlier in Halifax, NS than in Churchill, MB? (1 mark)
- How could Churchill, MB become as agriculturally productive as Suffield, Alberta? (1 mark)

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐
Teacher: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐

- In terms of the Laws of Thermodynamics, explain the flow of energy through the biosphere. Include the roles of photosynthesis and respiration. (4 marks)
- Describe the similarities between the processes of photosynthesis and cellular respiration. (2 marks)
- The production of some beef cattle in Alberta is based on fertilized fields of rye grass and clover. A typical square metre of pasture receives 2 093 400 kJ of visible light energy from the sun each year. This energy is accounted for as follows:

Energy reflected by the leaves	330 004 kJ
Energy lost by evaporation of water	1 046 700 kJ
Energy transmitted to the ground	669 888 kJ
Energy stored in new growth in plants	42 872 kJ
Energy lost during respiration in plants	3 936 kJ

- a. What percentage of energy is trapped by the plants through photosynthesis over the year? **(1 mark)**
- b. How much energy is available to the cattle if they eat all the plants? **(1 mark)**
- c. What is the albedo of the leaves? **(1 mark)**

The actual fate of a year's energy in a square metre of the pasture is as follows:

23 870 kJ	To decomposers
7 034 kJ	Eaten by other herbivores
6 102 kJ	Eaten by one cow
2 044 kJ	Lost by respiration from cow
3 818 kJ	Lost in wastes

- d. What percentage of the energy available from the plants is actually eaten by the cow? **(1 mark)**
- e. If 250 kJ of energy from the plants is actually stored in new growth in the cow, what is the percentage of energy available to you when you eat the beef? **(1 mark)**
- f. Describe 2 things the farmer could do to increase the energy conversion efficiency in the cow? **(2 marks)**
- g. In some tropical regions, native herbivores such as zebra and antelope yield more energy per unit area than introduced cattle. Suggest two reasons why this occurs. **(2 marks)**
- h. Compare the energy conversion efficiency in herbivores to carnivores. **(1 mark)**

Section 2 Assignment: Cycles of Matter

Read all the parts of your assignment carefully before beginning to develop your response pages. It is important to clearly identify each page with this information at the top.

Biology 20 - Module 1 Section 2 Assignment Page # Name and ID Number

1. Why is it essential that the four basic compounds (water, carbon-oxygen, nitrogen, and phosphorus) cycle in the biosphere? **(1 mark)**
2. Briefly explain how effective waste management can minimize the human impact on the biogeochemical cycles by practising the four R's: reduce, reuse, recycle and recover. **(4 marks)**

3. Briefly outline the role of water in the carbon-oxygen cycle, the nitrogen cycle, and the phosphorus cycle. **(3 marks)**
4. Explain why the hydrologic cycle is referred to as "the Earth's purification system." **(1 mark)**
5. Explain how the hydrologic cycle is the source of hydrologic energy. **(2 marks)**
6. Heavy demands for water are rapidly depleting freshwater supplies. The following data has been collected over the past half century.

Science Skills	
☐	A. Initiating
☒	B. Collecting
☒	C. Organizing
☒	D. Analysing
☐	E. Synthesizing
☐	F. Evaluating

TOTAL WORLD WATER USE, 1940-1990

Year	Total use (Km ³)
1940	903
1950	1117
1960	1964
1970	2496
1980	4381
1990	5529

Response
Page
Setup

- a. Graph these results on your own graph paper. Remember to give your graph a title. **(3 marks)**

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

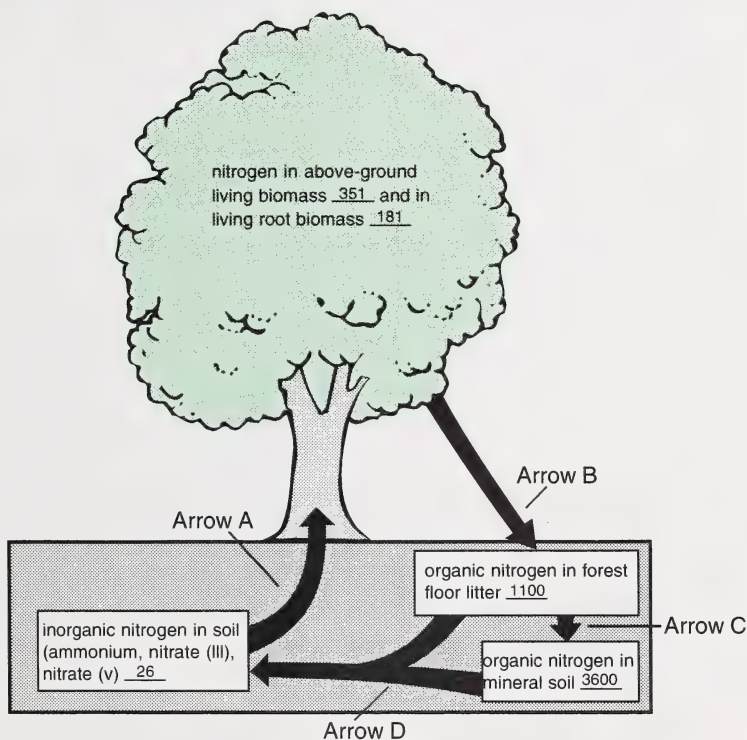
Self: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐
Teacher: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐

- b. Predict the total world water use for the year 2000. **(1 mark)**
- c. Explain why there has been an increased demand. **(3 marks)**
- d. Since water is a renewable resource, what natural processes will return it to the cycle? **(2 marks)**

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐
Teacher: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐

7. How are the carbon and oxygen cycles closely related to one another? **(2 marks)**
8. Trace the pathway a single carbon atom may follow as it goes from a fossil fuel to becoming a part of the air a human exhales. **(4 marks)**
9. In terms of the biogeochemical cycle of carbon, explain how global warming (the greenhouse effect) is increasing. **(6 marks)**
10. The following diagram illustrates the nitrogen cycle for a tree. The underlined numbers represent units of nitrogen. They're only relative to each other.



- a. Explain what each solid arrow represents. **(4 marks)**
 - b. Compare nitrogen fixation by bacteria to denitrification by bacteria. Describe the direction of movement of nitrogen between air and soil in each case. **(2 marks)**
11. Phosphates are an important part of fertilizers and natural organic soil. Describe two processes that must occur to phosphate before they can cycle directly from organisms to the exchange pool (soil, water, sediments) and back to organisms again. Start with phosphates in organisms. **(2 marks)**

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Section 3 Assignment: Nature's Balance

Read all the parts of your assignment carefully before beginning to develop your response pages. It is important to clearly identify each page with this information at the top.

Biology 20 – Module 1 Section 3 Assignment Page # Name and ID Number

1. Imagine that in the future humans live in domed cities protected from high UV radiation. Describe all the necessary conditions that must exist in this closed system for life to continue. Include the kind of dome needed and the sources of energy, water, carbon dioxide, and oxygen. Also include a plan for cycling nitrates and phosphates and recycling wastes. (Plan to write 1-1½ pages for your response.) **(8 marks)**
2. Describe how ozone is formed in the stratosphere. **(3 marks)**
3. Explain how pollutants like CFCs contribute to the depletion of ozone in the atmosphere. Include an explanation of the role of chlorine atoms. **(3 marks)**
4. Describe how an ozone hole over Alberta could affect agriculture and the human population? **(5 marks)**
5. Why is CO₂ the most abundant greenhouse gas? **(1 mark)**
6. Imagine that you have been hired by the United Nations to halt the increased global warming and save the planet. To accomplish this job, you must bring the levels of each greenhouse gas back to normal. Outline the order and methods you would employ to be successful at this task. Consider methane, CFCs, carbon dioxide, and nitrogen oxides (not necessarily in this order) in your answer. (Plan to write 1-1½ pages for your response.) **(10 marks)**

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☐ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self:	A. ☐	B. ☐	C. ☐	D. ☐	E. ☐	F. ☐
Teacher:	A. ☐	B. ☐	C. ☐	D. ☐	E. ☐	F. ☐

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